United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service, and North Dakota State Soil Conservation Committee

Soil Survey of Steele County, North Dakota

How To Use This Soil Survey

General Soil Map

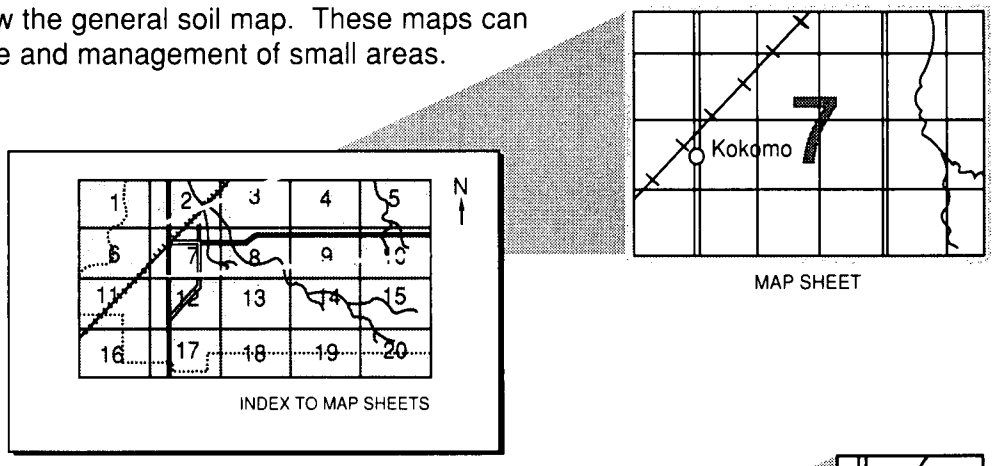
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

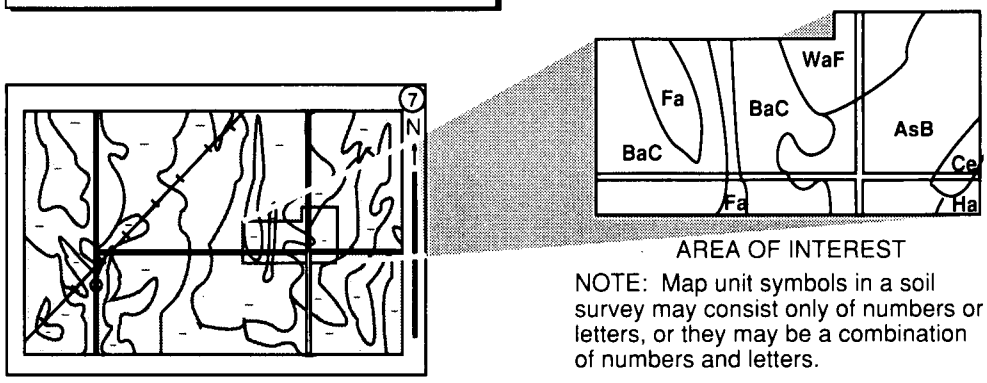
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1991. Soil names and descriptions were approved in 1991. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1991. The flights for the photo base were flown in 1981 and 1982. This survey was made cooperatively by the Natural Resources Conservation Service, the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee. The survey is part of the technical assistance furnished to the Steele County Soil Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Natural Resources Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Cropland in an area of Gardena, Overly, and Zell soils. The farmstead windbreaks and field shelterbelts help to control soil blowing.

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Issued September 1997

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Foreword

This soil survey contains information that can be used in land-planning programs in Steele County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the North Dakota Cooperative Extension Service.

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Soil Survey of Steele County, North Dakota

By Robert M. Murphy, Jacqueline R. Henderson, and Sally A. Fisk, Natural Resources Conservation Service

Fieldwork by Gary Lindgren, Brenda Frazer, Robert M. Murphy, Jacqueline R. Henderson, and Sally A. Fisk, Natural Resources Conservation Service, and Wesley Larson and Morris Roningen, professional soil classifiers

Map finishing by the North Dakota State Soil Conservation Committee

United States Department of Agriculture, Natural Resources Conservation Service,
in cooperation with
North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service,
and North Dakota State Soil Conservation Committee

STEELE COUNTY is in the east-central part of North Dakota (fig. 1). It has a total area of 457,800 acres, of which 456,700 acres is land and 1,100 acres is bodies of water more than 40 acres in size. Included in the land areas is an additional 395 acres of water bodies less than 40 acres in size. The county is bounded on the south by Barnes and Cass Counties, on the west by Griggs County, on the north by Nelson and Grand Forks Counties, and on the east by Traill County. The county seat is Finley, which is in the northwestern part of the county.

The major land resource areas in the county are the Central Black Glaciated Plains and the Red River Valley of the North. Both of these are in the Northern Great Plains Spring Wheat Land Resource Region *(13)*. The county is included in the Central Lowland physiographic province. The eastern edge of the county is part of the Lake Agassiz District, and the rest is on the Drift Prairie *(5)*.

Most of the soils in the county are very deep. They generally are suited to cultivated crops and to pasture, hay, and range. Unfavorable soil characteristics lower the potential of some soils for crops. Poor surface drainage, especially during wet periods, is the major management concern on flats and in depressions. Soil blowing is a hazard on many of the soils. The hazard is most severe on sandy and loamy soils on outwash plains, delta plains, beach ridges, and terraces. Many of these soils are underlain by sand and gravel and have a low or very low available water capacity. The county has about 11,000 acres of saline soils and 4,500 acres of soils having a sodic subsoil.

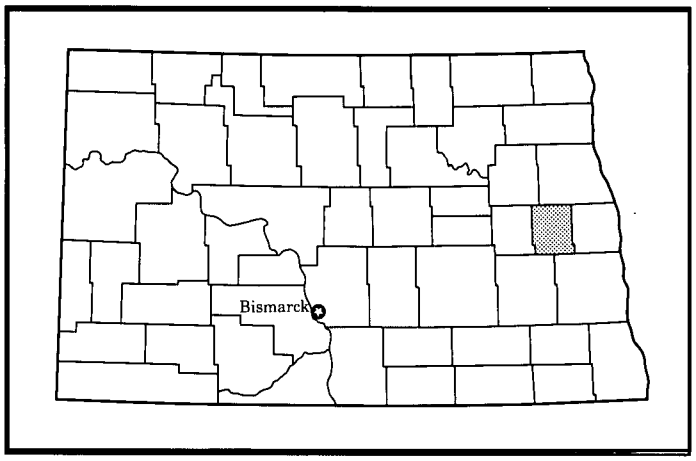

Figure 1.—Location of Steele County in North Dakota.

A general soil map of Steele County was published in

1963 and described in a report published in 1968 *(10)*. The present soil survey updates the earlier survey. It provides additional information and shows the soils in more detail.

General Nature of the County

This section provides general information about the county. It describes climate; history and development; physiography, relief, and drainage; and water supply.

Climate

Steele County is usually quite warm in summer. It has frequent spells of hot weather and occasional cool days. It is very cold in winter, when arctic air frequently surges over the survey area. Precipitation falls mainly during the growing season and is normally heaviest in late spring and early summer. Winter snowfall is limited, and it is blown into drifts, so that much of the ground is free of snow.

Several times each winter, storms with snow and high wind bring blizzard conditions to the survey area. Hail falls during summer thunderstorms in scattered small areas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Sharon, North Dakota, in the period 1951 to 1987. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 9 degrees F and the average daily minimum temperature is 0 degrees. The lowest temperature on record, which occurred at Sharon on January 28, 1966, is -37 degrees. In summer, the average temperature is 66 degrees and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred at Sharon on August 18, 1976, is 101 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 20.37 inches. Of this, nearly 16 inches, or about 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 13 inches. The heaviest 1-day rainfall during the period of record was 4 inches at Sharon on July 22, 1987. Thunderstorms occur on about 32 days each year.

The average seasonal snowfall is about 36 inches. The greatest snow depth at any one time during the period of record was 30 inches. On the average, 58 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 45 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 14 miles per hour, in spring.

History and Development

The Steele County area was first inhabited by Sioux and Chippewa Indians. The Chippewa inhabited the northern part of the county. The Sioux ranged throughout the southern part until General Sibley's campaigns of 1862 to 1865 moved them farther west. Bands of Chippewa continued to pass through the survey area, hunting and gathering food in the wooded areas, until the end of the settlement period.

The first settlers located in the southeastern part of the survey area in 1872. Most of the settlers were of Scandinavian ancestry. Some were German, English, or Irish.

Steele County was established in 1883 from parts of Griggs and Traill Counties. The county was named for Mr. Edward Steele, one of the owners of the Red River Land Company. Hope, in the south-central part of the county, was the first town and the first county seat. In 1885, Sherbrooke became the county seat because of its central location. In 1896, the Great Northern Railroad was built through the site of Finley. In 1918, the county seat was moved to Finley.

In 1885, Steele County had a population of 3,100 and had 400 farms and 7 manufacturers. The average size of the farms was 81 acres. By 1910, the population had grown to 7,161. It has dropped steadily since 1910. In 1990, the county had a population of 2,420 and had 380 farms. The decline in population and in the number of farms is partly the result of improvements in technology that have made working larger farms more feasible. A trend away from diversified farming is partly responsible for the decline in population.

The principal crops in the county are spring wheat, other small grain, sunflowers, soybeans, potatoes, and sugar beets. About 89 percent of the county is cropland

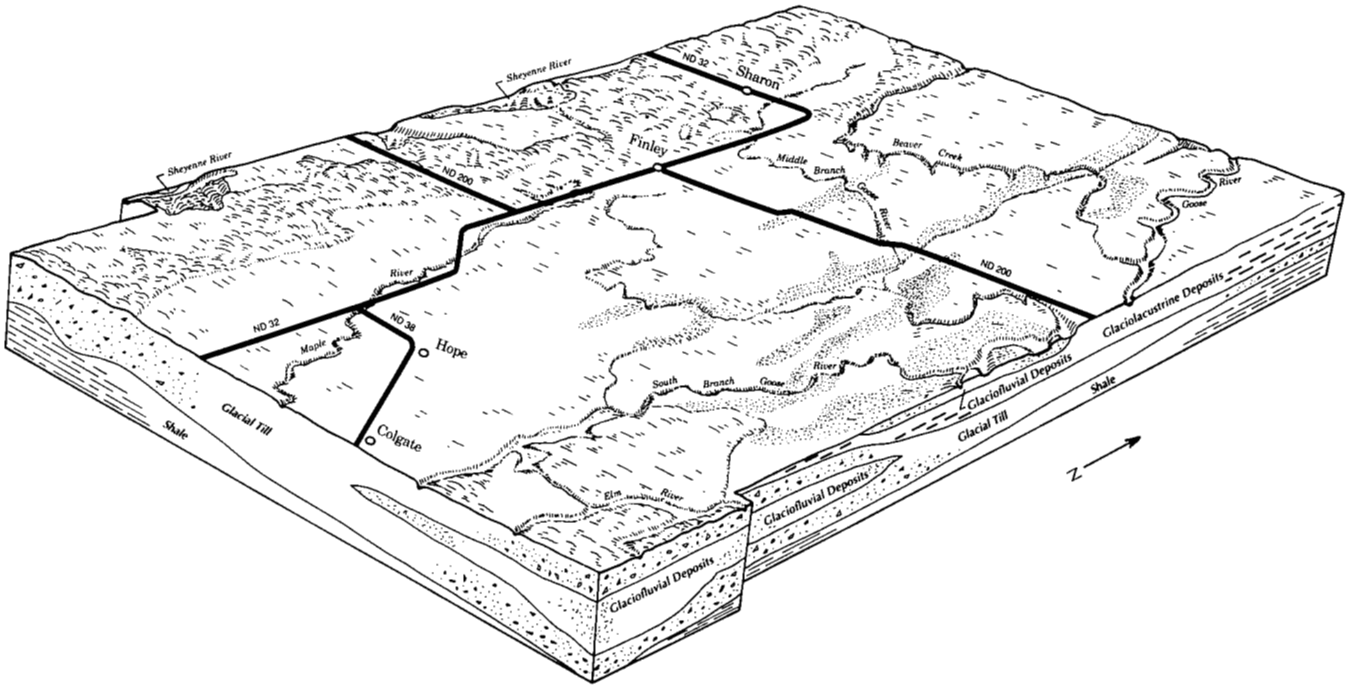

Figure 2.—The physiographic features of Steele County.

or pasture, 5 percent is native rangeland, and 6 percent is other land.

The Steele County Soil Conservation District was established in August 1946 after a legal referendum and election of supervisors on June 1, 1946.

Physiography, Relief, and Drainage

Steele County is in the Central Lowland physiographic province and includes both the Glaciated Plains and the Red River Valley *(5)*. The western two-thirds of the county is on the Drift Prairie, a gently undulating area covered by glacial deposits. The eastern part of the county is on the Glacial Lake Agassiz Plain, a nearly level area covered by glaciofluvial and lacustrine deposits. The county has five different physiographic regions, including a glacial till plain, a delta plain, a lake plain, major stream valleys, and an outwash plain and beach ridges (fig. 2).

The glacial till plain makes up about 75 percent of the county. The elevation of this plain ranges from about 1,200 to 1,500 feet above sea level. The plain generally consists of nearly level to gently rolling ground moraines and in some areas is characterized by isolated eskers and kames, stagnant ice features, and shallow drainageways.

The delta plain is in the eastern part of the county. The glaciofluvial sediments on this plain were deposited by a large river of glacial meltwater that entered Glacial Lake Agassiz. The plain consists mainly of fine sand and silt but has coarse sand in some areas. Local relief ranges from 2 to 10 feet.

The lake plain is in the eastern part of the county. It is mainly along the Goose River. The lacustrine deposits on this plain underlie the delta plain and are exposed in areas along the major drainageways where sediments have been removed by erosion. Local relief ranges from 0 to 5 feet.

The major stream valleys were cut by glacial meltwater. They are characterized by well drained, strongly sloping to steep soils on valley side slopes and poorly drained to well drained, level to undulating soils on flood plains and terraces. In the western two-thirds of the county, the stream valleys dissect areas of loamy glacial till, and in the eastern third they dissect areas of silty lacustrine and glaciofluvial deposits. Local relief ranges from 25 to 75 feet.

The outwash plain and beach ridges include nearly level flats, nearly level to gently rolling beach ridges, and steep, dissected areas along drainageways. The outwash plain consists of material that was deposited by meltwater flowing from the glaciers. The beach ridges consist of sand and gravel that have some lenses of silt. They represent old shorelines of Glacial

Lake Agassiz. Local relief is generally 0 to 10 feet in the areas of glacial outwash and 0 to 20 feet on the beach ridges.

Drainage in the county is generally southeastward. The western part of the county is drained by the south-flowing Sheyenne River. The eastern part is drained by the southeast-flowing Beaver Creek and Goose and Elm Rivers and the south-flowing Maple River. All of the rivers empty into the Red River of the North *(5)*.

Water Supply

Most of Steele County depends on ground water for domestic, livestock, and municipal uses *(7)*. The principal sources of the ground water are the Dakota and Pierre aquifers, which are in sedimentary bedrock, and the Galesburg, McVille, and Elk Valley aquifers, which are in glacial drift.

The Dakota aquifer is potentially the most productive bedrock aquifer in the county. It can yield as much as 500 gallons of water per minute at selected locations. Little use is made of this aquifer in Steele County because the water is saline and better water generally is available closer to the surface.

The Pierre aquifer is shallow. Wells tapping this aquifer can yield as much as 10 gallons of water per minute. They provide water for many farms in the northwestern part of the county.

The Galesburg aquifer underlies the southeastern part of the county. It can yield as much as 1,000 gallons per minute. It provides water for the irrigation systems and the rural water districts in a large part of the county. The McVille aquifer can yield as much as 500 gallons per minute, and the Elk Valley aquifer, which underlies the northeastern part of the county, can yield as much as 30 gallons per minute. The water from all three of these aquifers is very hard.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet

local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used in making this survey are described in the National Soils Handbook of the Natural Resources Conservation Service and the "Soil Survey Manual" *(14)*. "The Major Soils of North Dakota" *(9)*, "Soil Taxonomy" *(12)*, and "Land Resource Regions and Major Land Resource Areas of the United States" *(13)* were among references used. The procedures used in determining the nature and characteristics of the soils are described under the heading "How This Survey Was Made."

All soil mapping was done on field sheets developed from high-altitude black and white aerial photographs. The scale of the field sheets was 1:20,000, or 3.168 inches to the mile. Detail on the field sheets was checked against older aerial photography, against color infrared photography, and in some instances against topographic maps.

Soil delineations were drawn on the field sheets as soil scientists traversed the land on foot, by a pickup having a mounted hydraulic soil probe, or by an all-terrain vehicle. The traverses crossed all of the major landforms and were at intervals close enough for the soil scientists to locate contrasting soil areas of about 3 to 5 acres. Soils were examined to a depth of 3 to 5 feet, depending on the kind of soil. Soil properties, including color, texture, structure, horizonation, and content of salts and stones, were examined.

All map units were characterized for soil variability by transects of representative areas. A transect is a series of detailed soil examinations of a map unit delineation. The purpose of the transect is to ascertain the

composition of the various kinds of soil and the range of soil properties in the delineation. One transect was required for each 1,000 acres of the unit mapped.

Data collected from the transects were used to determine map unit names and establish the range of composition of each map unit. The statistical method explained by R.W. Arnold was used *(3)*. This statistical analysis indicates that the map unit composition given in the map unit descriptions is at least 90 percent accurate.

Each soil map unit was documented by at least one pedon description for each soil series identified in its name. Seven pedons were sampled for engineering properties in 1988 and 1989. The analyses were made by the North Dakota State Department of Transportation.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts, differing soil patterns, and differences in the design of the associations, some of the soil boundaries and soil names on the general soil map of this county do not match those on the general soil maps of Barnes, Cass, Grand Forks, Griggs, Nelson, and Traill Counties.

Soil Descriptions

Level to Gently Rolling, Loamy and Silty Soils on Till Plains

These soils formed in glacial till and alluvium. They make up about 69 percent of the county. In most areas surface water flows into marshes and depressions, but in some areas it flows into drainageways.

These soils are used primarily for cultivated crops. In some small areas they are used for hay, pasture, or range. They are suited to cultivated crops. The Parnell soils are used for wetland wildlife habitat. The main concerns in managing cultivated areas are controlling soil blowing and water erosion, overcoming wetness, and maintaining or improving tilth and fertility.

1. Barnes-Hamerly-Svea Association

Very deep, level to undulating, well drained to somewhat poorly drained, medium textured soils

This association consists of soils on rises and flats on till plains. Scattered depressions, marshes, drainageways, knolls, and ridges are throughout the association. Slopes are short and irregular. They range from 0 to 6 percent.

This association makes up about 35 percent of the county. It is about 44 percent Barnes soils, 22 percent Hamerly soils, 14 percent Svea soils, and 20 percent soils of minor extent (fig. 3).

The level to undulating, well drained Barnes soils are on summits. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam.

The level and nearly level, somewhat poorly drained Hamerly soils are on flats. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 28 inches thick. It is light brownish gray in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The level to undulating, moderately well drained Svea soils are on foot slopes. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam.

Of minor extent in this association are Binford, Lamoure, Parnell, and Tonka soils and the saline Vallers soils. Also of minor extent are a few areas of

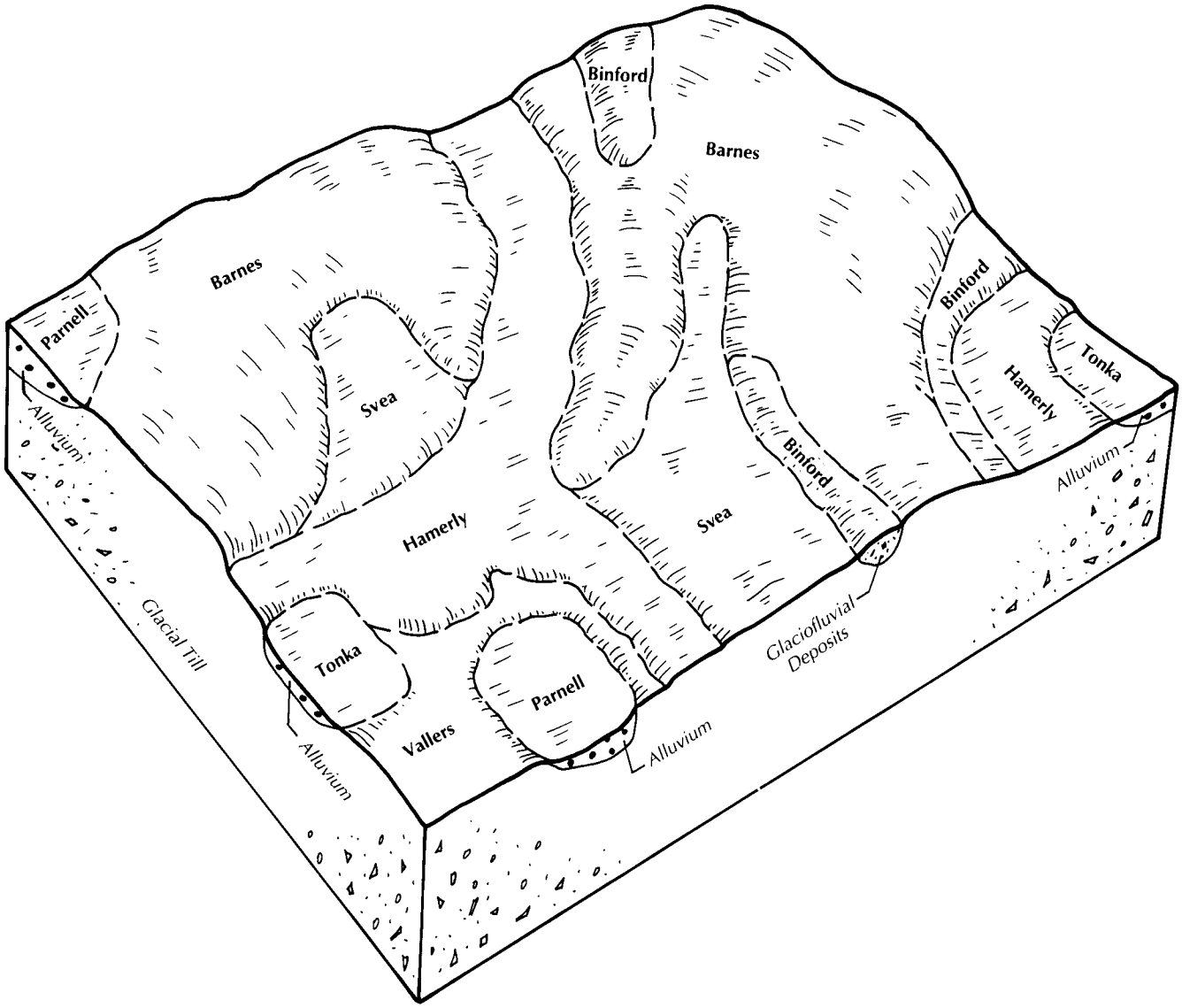

Figure 3.—Typical pattern of soils and parent material in the Barnes-Hamerly-Svea association.

rolling to steep soils. The somewhat excessively drained Binford soils are intermingled with areas of the Barnes soils. The poorly drained Lamoure soils are on flood plains. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The poorly drained, saline Vallers soils are on flats. They have accumulations of salts in the surface layer and subsoil.

Most areas are used for cultivated crops. A few are used for hay, pasture, or range. This association is well suited to small grain, sunflowers, and grass-legume hay. Controlling water erosion on the undulating Barnes and Svea soils and soil blowing on the Hamerly soils is the main concern in managing cultivated areas.

2. Svea-Buse-Parnell Association

Very deep, level to gently rolling, moderately well drained, well drained, and very poorly drained, medium textured and moderately fine textured soils

This association consists of soils on rises, knolls, and ridges and in depressions on till plains. Slopes are short and irregular. They range from 0 to 9 percent.

This association makes up about 14 percent of the county. It is about 38 percent Svea soils, 29 percent Buse soils, 10 percent Parnell soils, and 23 percent soils of minor extent (fig. 4).

The level to gently rolling, moderately well drained

Svea soils are on foot slopes. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam.

The undulating and gently rolling, well drained Buse soils are on shoulder slopes and summits. Typically, the surface layer is very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part.

The level, very poorly drained Parnell soils are in depressions. Typically, the surface soil is black silty clay loam about 12 inches thick. The subsoil is silty clay about 38 inches thick. It is very dark gray in the upper part, very dark gray and mottled in the next part, and dark olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay.

Binford, Coe, and Hamerly are the minor soils in this association. Also of minor extent are a few areas of rolling to hilly soils. The somewhat excessively drained

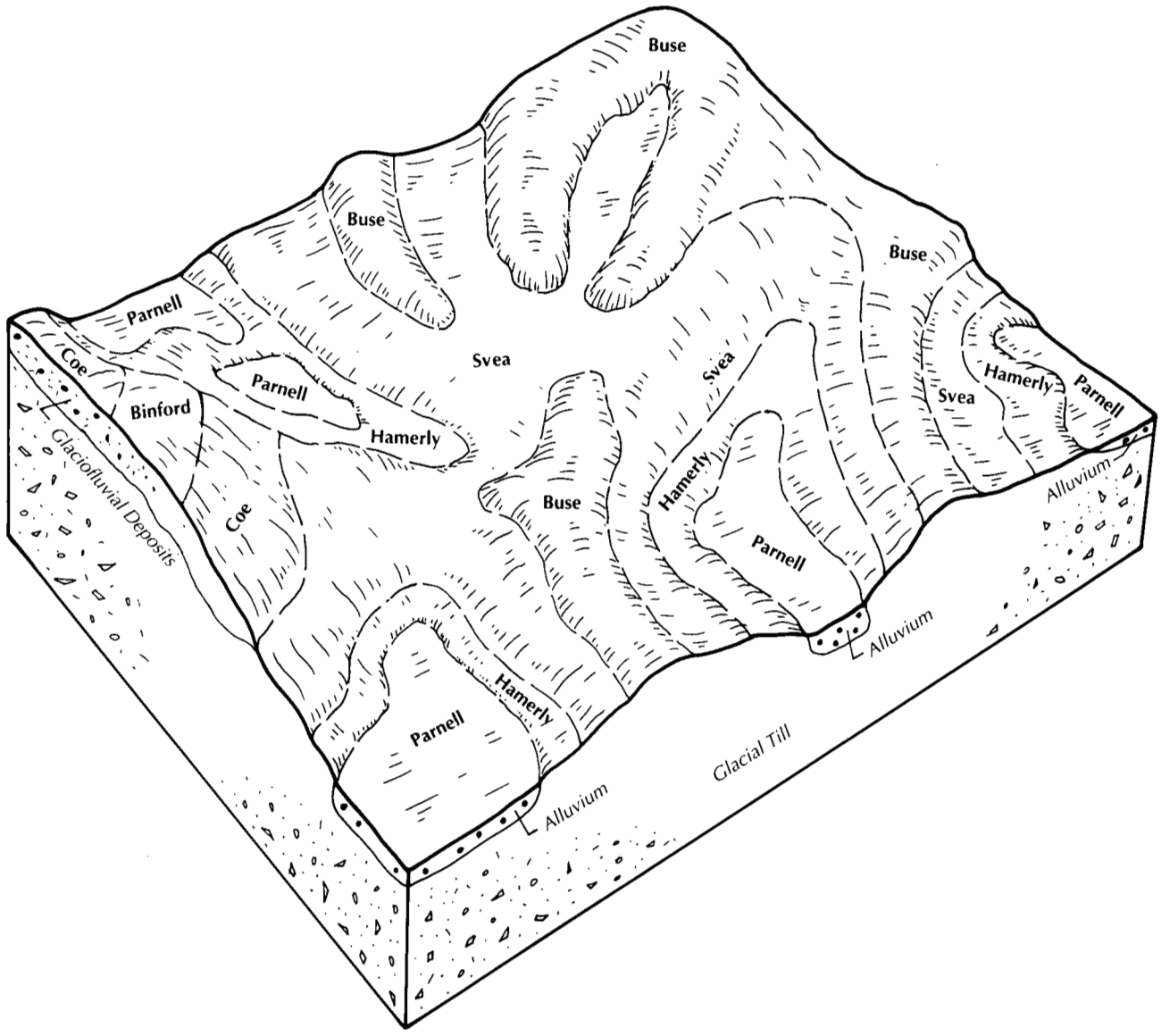

Figure 4.—Typical pattern of soils and parent material in the Svea-Buse-Parnell association.

Binford and excessively drained Coe soils are intermingled with areas of the Buse soils. The somewhat poorly drained Hamerly soils are on flats between and surrounding depressions.

Most areas are used for cultivated crops. The Parnell soils generally are used for native hay, pasture, or wetland wildlife habitat. This association generally is suited to small grain, sunflowers, and grass-legume hay. The gently rolling soils, however, are poorly suited to cultivated crops because they are susceptible to water erosion. Controlling water erosion on the Buse and Svea soils and soil blowing on the Buse soils and overcoming wetness in the Parnell soils are the main concerns in managing cultivated areas.

3. Cresbard-Svea-Hamerly Association

Very deep, level and nearly level, moderately well drained and somewhat poorly drained, medium textured soils

This association consists of soils on flats and rises on till plains. Scattered depressions and a few knolls are throughout the association. Slopes range from 0 to 3 percent.

This association makes up about 3 percent of the county. It is about 21 percent Cresbard soils, 21 percent Svea soils, 20 percent saline Hamerly soils, and 38 percent soils of minor extent.

The moderately well drained, sodic Cresbard soils are on flats. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The next layer is black and very dark gray clay loam about 2 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam; dark grayish brown clay loam; light olive brown, calcareous clay loam; and light olive brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The moderately well drained Svea soils are on rises. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam.

The somewhat poorly drained, saline Hamerly soils are on the lower flats. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 28 inches thick. It is light brownish gray in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Brantford, Buse, Divide, Edgeley, Miranda, and Tonka are the minor soils in this association. Also of minor extent are a few areas of undulating soils. The well drained Brantford soils are on flats. They are slightly higher on the landscape than the Cresbard and Svea soils. The well drained Buse soils are on knolls. Divide and Miranda soils are intermingled with areas of the saline Hamerly soils. Divide soils are highly calcareous and have a substratum of sand and gravel. Miranda soils have a very dense, sodic subsoil and have accumulations of salts within a depth of 16 inches. The well drained Edgeley soils are on flats directly adjacent to stream valleys. The poorly drained Tonka soils are in depressions.

Most areas are used for cultivated crops. Some are used for hay or pasture. This association generally is suited to small grain, sunflowers, and grass-legume hay. The saline Hamerly soils and the minor Miranda soils, however, are poorly suited to most cultivated crops. Overcoming the effects of the dense, sodic subsoil in the Cresbard soils and salinity in the saline Hamerly soils, controlling soil blowing on the saline Hamerly soils, and improving or maintaining tilth and fertility in the Cresbard and Svea soils are the main concerns in managing cultivated areas.

4. Hamerly-Tonka-Barnes Association

Very deep, level to undulating, somewhat poorly drained, poorly drained, and well drained, medium textured soils

This association consists of soils on flats and rises and in depressions on till plains. Scattered marshes, knolls, and drainageways are throughout the association. Slopes range from 0 to 6 percent.

This association makes up about 8 percent of the county. It is about 45 percent Hamerly soils, 19 percent Tonka soils, 17 percent Barnes soils, and 19 percent soils of minor extent (fig. 5).

The level and nearly level, somewhat poorly drained Hamerly soils are on flats. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 28 inches thick. It is light brownish gray in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

The level, poorly drained Tonka soils are in depressions. Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is mottled silt loam about 14 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The subsoil is about 27 inches thick. It is very dark gray, mottled silty clay loam in the upper part and black silty clay in the lower part. The next layer is olive gray,

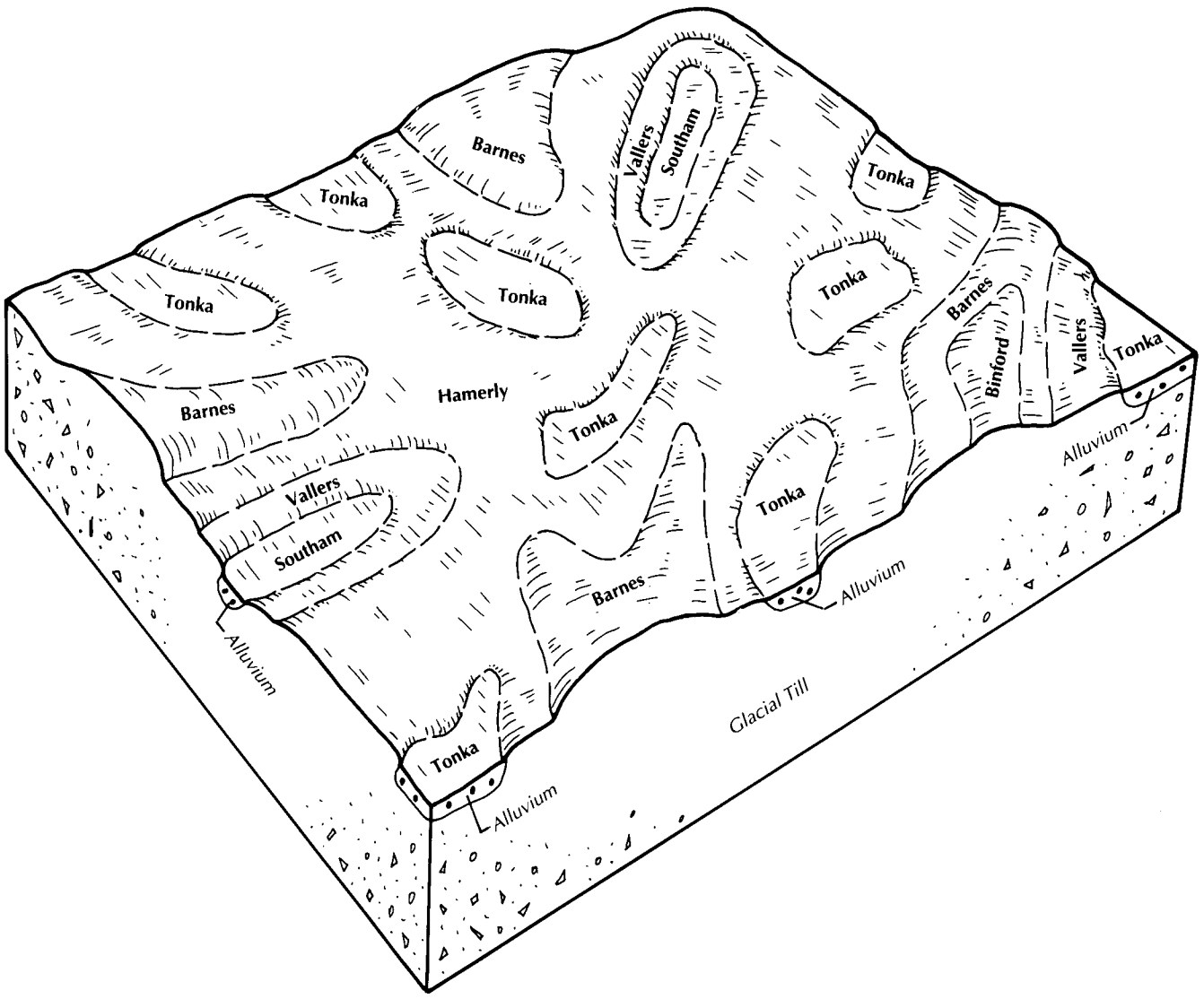

Figure 5.—Typical pattern of soils and parent material in the Hamerly-Tonka-Barnes association.

mottled clay loam about 10 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous clay loam.

The level to undulating, well drained Barnes soils are on rises. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam.

Of minor extent in this association are Binford, Lamoure, and Southam soils and the saline Vallers soils. The somewhat excessively drained Binford soils are intermingled with areas of the Barnes soils. Lamoure soils contain more silt and less sand than the Hamerly and Barnes soils. They are on flood plains. The very poorly drained Southam soils are in depressions. The saline Vallers soils have accumulations of salts in the surface layer and subsoil. They are on the lower flats.

Most areas are used for cultivated crops. A few are used for hay or pasture. This association is well suited to small grain, sunflowers, and grass-legume hay. Controlling soil blowing on the Hamerly soils and water erosion on the Barnes soils and overcoming wetness in the Tonka soils are the main concerns in managing cultivated areas.

5. Heimdal-Emrick Association

Very deep, level to gently rolling, well drained, medium textured soils

This association consists of soils on rises, knolls, and ridges on till plains. Scattered drainageways, depressions, marshes, knolls, and ridges are throughout the association. Slopes range from 0 to 9 percent.

This association makes up about 6 percent of the county. It is about 45 percent Heimdal soils, 25 percent Emrick soils, and 30 percent soils of minor extent.

The level to gently rolling Heimdal soils are on side slopes and summits. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 31 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

The level to undulating Emrick soils are on foot slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 41 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light yellowish brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

Binford, Coe, Colvin, Fram, Maddock, Rauville, and Tonka are the minor soils in this association. Also of minor extent are a few areas of rolling soils. The somewhat excessively drained Binford and excessively drained Coe soils are intermingled with areas of the Heimdal soils. The poorly drained Colvin and somewhat poorly drained Fram soils are on flats. Maddock soils are sandy throughout. They are intermingled with areas of the Heimdal soils. The very poorly drained Rauville soils are on flood plains. The poorly drained Tonka soils are in depressions.

Most areas are used for cultivated crops. A few are used for hay or pasture. This association generally is well suited to small grain, sunflowers, and grass-legume hay. The gently rolling soils, however, are poorly suited to cultivated crops because of a severe hazard of water erosion. Controlling water erosion is the main concern in managing cultivated areas.

6. Fram-Emrick-Heimdal Association

Very deep, level to undulating, somewhat poorly drained and well drained, medium textured soils

This association consists of soils on flats and rises on till plains. Scattered marshes, depressions, and drainageways are throughout the association. Slopes range from 0 to 6 percent.

This association makes up about 3 percent of the county. It is about 42 percent Fram soils, 20 percent Emrick soils, 18 percent Heimdal soils, and 20 percent soils of minor extent.

The level and nearly level, somewhat poorly drained Fram soils are on flats. Typically, the surface layer is black, calcareous loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 28 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam.

The level to undulating, well drained Emrick soils are on foot slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 41 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light yellowish brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam.

The level to undulating, well drained Heimdal soils are on summits. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 31 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Of minor extent in this association are Binford, Esmond, Maddock, Rauville, Southam, and Tonka soils and the saline Vallers soils. The somewhat excessively drained Binford soils are intermingled with areas of the Heimdal soil. The well drained Esmond soils are on shoulder slopes and summits. They have a calcareous subsoil. Maddock soils are sandy throughout. They are on rises. The very poorly drained Rauville soils are on flood plains. The very poorly drained Southam soils are in deep depressions. The poorly drained Tonka soils are in depressions. The poorly drained, saline Vallers soils are on the lower flats.

Most areas are used for cultivated crops. Some are used for hay or pasture. This association is well suited to small grain, sunflowers, and grass-legume hay. Controlling soil blowing on the Fram soils and water erosion on the Emrick and Heimdal soils is the main concern in managing cultivated areas.

Level to Steep, Loamy and Silty Soils in Valleys and on Till Plains, Flood Plains, and Lake Plains

These soils formed in colluvium, glacial till, glaciolacustrine deposits, alluvium, and material weathered from shale bedrock. They make up about 7 percent of the county. In most areas surface water flows into streams. In a few areas, however, it flows into scattered marshes and depressions throughout the valleys.

Generally, the level to moderately sloping soils are used for cultivated crops, pasture, or hay. The level to gently sloping or undulating soils are well suited to cultivated crops, but the moderately sloping soils are poorly suited. The moderately steep or steep soils are generally unsuited to cultivated crops and are used for range, grazeable woodland, pasture, or wildlife habitat. The main concerns in managing cultivated areas are controlling soil blowing and water erosion, overcoming flooding and wetness, and maintaining or improving tilth and fertility.

7. Buse-Barnes-Lamoure Association

Very deep, level to steep, well drained and poorly drained, medium textured soils

This association consists of soils on beaches and ridges and in drainageways in valleys on till plains. Slopes range from 0 to 35 percent.

This association makes up about 3 percent of the county. It is about 32 percent Buse soils, 29 percent Barnes soils, 17 percent Lamoure soils, and 22 percent soils of minor extent.

The moderately sloping to steep, well drained Buse soils are on shoulder slopes and summits. Typically, the surface layer is very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part.

The moderately sloping to hilly, well drained Barnes soils are on side slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam.

The level, poorly drained, calcareous Lamoure soils are in drainageways. Typically, the surface soil is black, calcareous silt loam about 30 inches thick. The substratum to a depth of about 60 inches is mottled, calcareous silt loam. It is dark gray in the upper part and olive gray in the lower part.

Coe, Divide, LaDelle, Svea, and Walsh are the minor soils in this association. The excessively drained Coe and somewhat poorly drained Divide soils are on terraces. The moderately well drained LaDelle soils are on flood plains. The moderately well drained Svea and well drained Walsh soils are on foot slopes. The dark upper part of Walsh soils is thicker than that of the Barnes soils.

Most areas are used for range or wildlife habitat. Some areas of the Lamoure soils and the minor LaDelle, Walsh, and Svea soils are used for hay, pasture, or cultivated crops. Native woodland is common in some areas on flood plains and in the steeper areas, particularly along the Sheyenne River. This association is generally unsuited to cultivated crops because of the slope and a very severe hazard of water erosion. In some areas, however, the moderately well drained or well drained, level to gently sloping minor soils are well suited. Controlling water erosion on the Buse and Barnes soils and soil blowing on the Buse and Lamoure soils and overcoming flooding and wetness in areas of the Lamoure soils are the main concerns in managing the soils for cultivated crops.

8. Edgeley-Esmond-LaDelle Association

Moderately deep and very deep, level to steep, well drained and moderately well drained, medium textured and moderately fine textured soils

This association consists of soils on flats, knolls, and ridges in valleys and on till plains. Drainageways are throughout the association. Slopes range from 0 to 35 percent.

This association makes up about 1 percent of the county. It is about 37 percent Edgeley soils, 18 percent Esmond soils, 10 percent LaDelle soils, and 35 percent soils of minor extent.

The moderately deep, strongly sloping to steep, well drained Edgeley soils are on side slopes. Typically, the surface layer is black silt loam about 8 inches thick. The subsoil is about 28 inches thick. It is dark brown loam in the upper part and dark grayish brown, calcareous silty clay loam in the lower part. Below this is dark olive gray, weathered shale bedrock.

The very deep, moderately sloping to steep, well drained Esmond soils are on shoulder slopes and summits. Typically, the surface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 19 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

The very deep, level and nearly level, moderately well drained LaDelle soils are on flats on flood plains. Typically, the surface soil is black silty clay loam about 24 inches thick. The subsoil is very dark grayish brown silty clay loam about 20 inches thick. The next layer is very dark gray, calcareous silty clay loam about 4 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, calcareous silty clay loam.

Barnes, Coe, Embden, and Maddock are the minor soils in this association. The well drained, very deep Barnes soils are on uplands adjacent to stream valleys.

They contain more clay than the Esmond soils. The excessively drained Coe soils are on terraces. The very deep Embden and Maddock soils are intermingled with areas of the Edgeley soils.

Most areas are used for range or wildlife habitat. Many areas of the LaDelle soils are used for cultivated crops, pasture, or hay. Native woodland is common in some areas on flood plains and in the steeper areas. This association is generally unsuited to cultivated crops because of the slope and a very severe hazard of water erosion. In some areas, however, the moderately well drained or well drained, level to gently sloping soils are well suited. Controlling soil blowing on the Esmond soils and water erosion on the Edgeley and Esmond soils, overcoming flooding on the LaDelle soils, and maintaining or improving tilth and fertility in the LaDelle soils are the main concerns in managing cultivated areas.

9. LaDelle-Overly-Zell Association

Very deep, level to moderately steep, moderately well drained and well drained, medium textured soils

This association consists of soils on flats, knolls, and ridges on lake plains and flood plains. Drainageways are throughout the association. Slopes range from 0 to 25 percent.

This association makes up about 3 percent of the county. It is about 27 percent LaDelle soils, 27 percent Overly soils, 19 percent Zell soils, and 27 percent soils of minor extent.

The level and nearly level, moderately well drained LaDelle soils are on flats on flood plains. Typically, the surface soil is black silt loam about 20 inches thick. The subsoil is silt loam about 16 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The next layer is very dark grayish brown, calcareous silty clay loam about 2 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous silt loam.

The moderately sloping and strongly sloping, well drained Overly soils are on side slopes. Typically, the surface soil is silt loam about 14 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is silty clay loam about 17 inches thick. It is very dark grayish brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and grayish brown silty clay loam in the upper part; light yellowish brown, mottled silt loam in the next part; and grayish brown and light olive brown, mottled silty clay loam in the lower part.

The moderately sloping to moderately steep, well drained Zell soils are on shoulder slopes and summits. Typically, the surface layer is very dark grayish brown, calcareous silt loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and light brownish gray silt loam in the upper part, light yellowish brown and light brownish gray silt loam and very fine sandy loam in the next part, and light olive brown silt loam in the lower part.

Barnes, Buse, Embden, and Swenoda are the minor soils in this association. Also of minor extent are a few areas of steep or very steep soils. Barnes and Buse soils contain more sand and less silt than the LaDelle and Overly soils. Barnes soils are intermingled with areas of the Overly soils. Buse soils are intermingled with areas of the Zell soils. Embden and Swenoda soils contain more sand and less clay than the Overly and LaDelle soils. They are on uplands adjacent to stream valleys. Swenoda soils are on flats above the Zell soils.

Most areas are used for cultivated crops, pasture, hay, or grazeable woodland. The level and nearly level soils are well suited to small grain, corn, soybeans, and sunflowers. The moderately sloping to moderately steep soils generally are poorly suited or unsuited to cultivated crops because of the slope and a severe hazard of water erosion. Maintaining tilth and fertility in the LaDelle soils and controlling soil blowing on the Zell soils and water erosion on the Overly and Zell soils are the main concerns in managing cultivated areas.

Level to Undulating, Loamy and Sandy Soils on Delta Plains, Lake Plains, Outwash Plains, Till Plains, and Terraces

These soils formed in glaciolacustrine deposits, glaciofluvial deposits, and glacial till. They make up about 8 percent of the county. In most areas surface water is removed by deep seepage, natural runoff, or field drains and road ditches.

These soils are used primarily for cultivated crops. In some small areas they are used for pasture, hay, or range. They are suited to cultivated crops. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness or wetness.

10. Wyndmere-Tiffany-Swenoda Association

Very deep, level, somewhat poorly drained, poorly drained, and moderately well drained, moderately coarse textured and medium textured soils

This association consists of soils on flats and in swales and depressions on delta plains, lake plains, and till plains. A few drainageways cross the

association. Slopes are 0 to 1 percent.

This association makes up about 3 percent of the county. It is about 27 percent Wyndmere soils, 26 percent Tiffany soils, 26 percent Swenoda soils, and 21 percent soils of minor extent.

The somewhat poorly drained Wyndmere soils are on flats. Typically, the surface layer is black, calcareous fine sandy loam about 8 inches thick. The subsoil is calcareous fine sandy loam about 21 inches thick. It is gray in the upper part, brown in the next part, and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is calcareous and mottled. In sequence downward, it is light yellowish brown loamy fine sand, light olive brown fine sandy loam, olive gray silty clay loam, and light yellowish brown silty clay loam.

The poorly drained Tiffany soils are in swales and depressions. Typically, the surface soil is about 22 inches thick. It is black loam in the upper part and very dark gray, mottled fine sandy loam in the lower part. The substratum to a depth of about 60 inches is olive gray and mottled. In sequence downward, it is fine sandy loam, loamy fine sand, fine sandy loam, silty clay loam, and calcareous silty clay loam and silt loam.

The moderately well drained Swenoda soils are on the higher flats. Typically, the surface soil is fine sandy loam about 15 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil extends to a depth of about 60 inches. In sequence downward, it is very dark grayish brown fine sandy loam; olive brown, mottled fine sandy loam; dark grayish brown, mottled loam; light brownish gray, mottled, calcareous silt loam; and grayish brown, mottled, calcareous silty clay loam.

Arvilla, Bearden, Hecla, Overly, Velva, and Zell are the minor soils in this association. The somewhat excessively drained Arvilla soils are on flats and side slopes on beach ridges. Bearden soils are highly calcareous and contain more silt and clay and less sand in the upper part than the Wyndmere soil. They are intermingled with areas of the Wyndmere soils on flats. Hecla and Overly soils are intermingled with areas of the Swenoda soils on flats. Hecla soils are sandy throughout. Overly soils contain more silt and clay and less sand in the upper part than the Swenoda soils. The well drained Velva soils are on flood plains and terraces. The well drained Zell soils are on shoulder slopes and summits.

Most areas are used for cultivated crops. A few are used for hay or pasture. This association is suited to small grain, corn, soybeans, and sunflowers. Controlling soil blowing on the Wyndmere and Swenoda soils and overcoming wetness in the Tiffany soils are the main concerns in managing cultivated areas.

11. Hecla-Arvilla-Arveson Association

Very deep, level to undulating, moderately well drained, somewhat excessively drained, and poorly drained, coarse textured, moderately coarse textured, and medium textured soils

This association consists of soils on flats and beach ridges and in swales on delta plains. Slopes range from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 35 percent Hecla soils, 20 percent Arvilla soils, 18 percent Arveson soils, and 27 percent soils of minor extent.

The level and nearly level, moderately well drained Hecla soils are on flats. Typically, the surface soil is loamy fine sand about 24 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is very dark grayish brown fine sand about 7 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is light olive brown in the upper part and olive brown in the lower part.

The level to undulating, somewhat excessively drained Arvilla soils are on beach ridges. Typically, the surface layer is black sandy loam about 8 inches thick. The subsoil is about 20 inches thick. It is very dark brown sandy loam in the upper part, dark yellowish brown sandy loam in the next part, and grayish brown, calcareous gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous gravelly coarse sand.

The level, poorly drained Arveson soils are on the lower flats and in swales. Typically, the surface soil is black, calcareous loam about 11 inches thick. The next layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is dark gray, calcareous fine sandy loam about 8 inches thick. The substratum to a depth of about 60 inches is calcareous. It is grayish brown fine sandy loam in the upper part and olive gray, mottled fine sand in the lower part.

Emrick, Gilby, Kratka, and Swenoda are the minor soils in this association. The well drained Emrick soils are on flats. The somewhat poorly drained Gilby soils are on flats between the beach ridges. Kratka soils are mottled in the lower part of the surface soil and are silty clay loam in the lower part of the substratum. They are intermingled with areas of the Arveson soils. Swenoda soils have a surface soil of fine sandy loam. They are intermingled with areas of the Hecla soils.

Most areas are used for cultivated crops. Some are used for hay or pasture. This association generally is poorly suited to most cultivated crops because of a severe hazard of soil blowing and a low available water capacity in the Hecla and Arvilla soils. Overcoming wetness in the Arveson soils and droughtiness in the

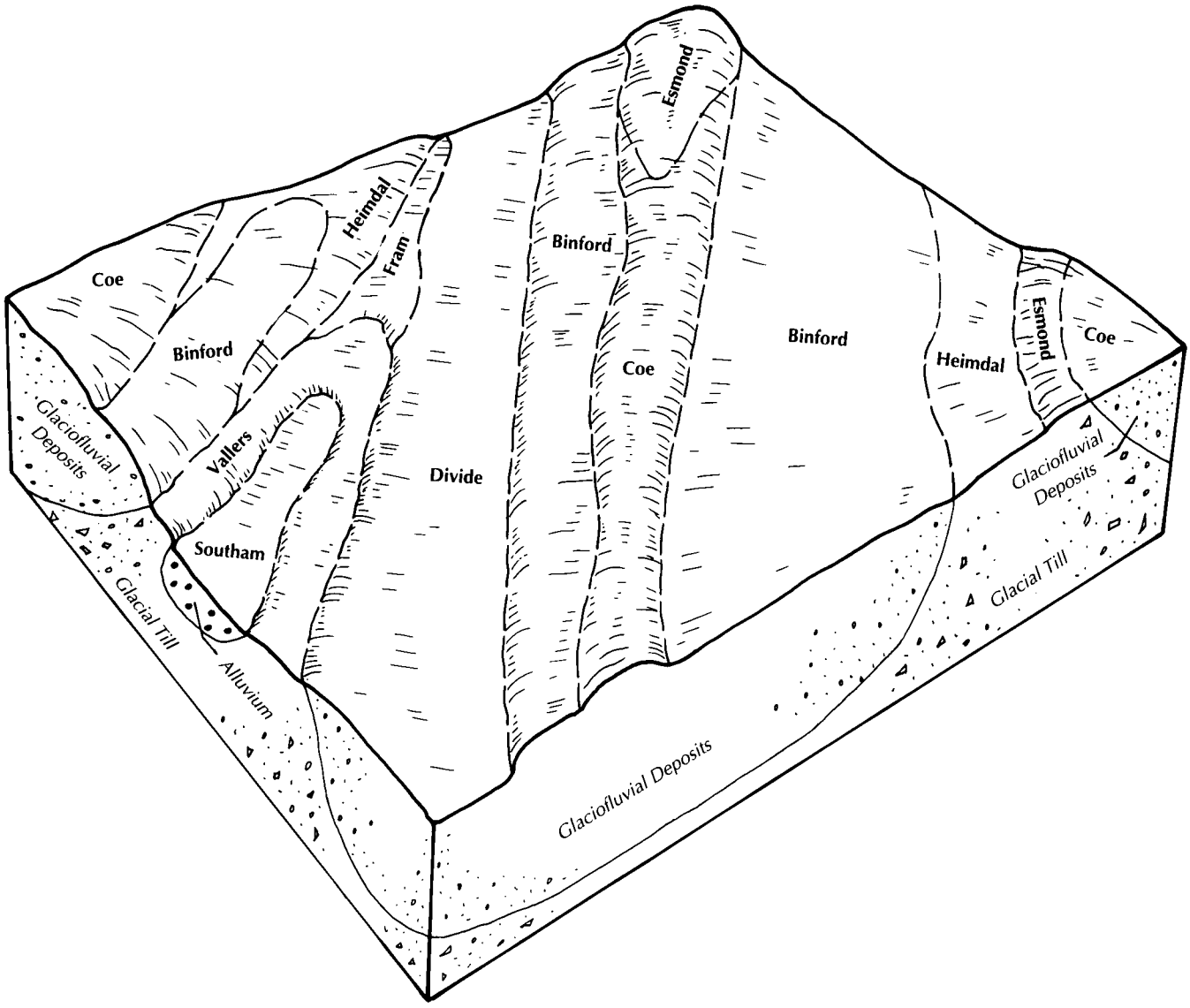

Figure 6.—Typical pattern of soils and parent material in the Binford-Divide-Coe association.

Hecla and Arvilla soils and controlling soil blowing are the main concerns in managing cultivated areas.

12. Binford-Divide-Coe Association

Very deep, level to undulating, somewhat excessively drained, somewhat poorly drained, and excessively drained, moderately coarse textured and medium textured soils

This association consists of soils on flats and rises on outwash plains and terraces. Scattered marshes, depressions, drainageways, knolls, and ridges are throughout the association. Slopes range from 0 to 6 percent.

This association makes up about 4 percent of the county. It is about 29 percent Binford soils, 22 percent Divide soils, 20 percent Coe soils, and 29 percent soils of minor extent (fig. 6).

The level to undulating, somewhat excessively drained Binford soils are on flats and rises. Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is dark grayish brown sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous. It is very dark grayish brown very gravelly coarse sand in the upper part, brown gravelly coarse sand in the next part, and dark grayish brown gravelly coarse sand in the lower part.

The level and nearly level, somewhat poorly drained Divide soils are on the lower flats. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is about 17 inches thick. It is grayish brown and calcareous. It is loam in the upper part and gravelly sandy loam in the lower part. The substratum to a depth of about 60 inches is grayish brown and calcareous. It is mottled very gravelly coarse sand in the upper part and sand in the lower part.

The level to undulating, excessively drained Coe soils are on flats and rises. Typically, the surface layer is very dark gray, calcareous sandy loam or gravelly sandy loam about 8 inches thick. The subsoil is dark grayish brown, calcareous very gravelly coarse sand about 9 inches thick. The substratum to a depth of about 60 inches is calcareous. It is dark grayish brown very gravelly coarse sand in the upper part, grayish brown gravelly sand in the next part, and dark grayish brown very gravelly coarse sand in the lower part.

Of minor extent in this association are Esmond, Fram, Heimdal, Lamoure, and Southam soils and the saline Vallers soils. Also of minor extent are a few areas of gently rolling and rolling soils. The well drained Esmond and Heimdal soils are intermingled with areas of the Binford soils. Fram soils have a substratum of loam. They are intermingled with areas of the Divide soils. The poorly drained Lamoure soils are on flood plains. The very poorly drained Southam soils are in depressions. The poorly drained, saline Vallers soils are on the lower flats.

Most areas are used for cultivated crops. Some are used for hay, pasture, or range. This association generally is poorly suited to cultivated crops because of a low or very low available water capacity in the Binford and Coe soils and a severe hazard of soil blowing. Overcoming droughtiness in the Binford and Coe soils and controlling soil blowing are the main concerns in managing cultivated areas.

Level and Nearly Level, Loamy and Silty Soils on Lake Plains

These soils formed in glaciolacustrine deposits and glacial till. They make up about 16 percent of the county. In most areas surface water flows into scattered marshes and depressions or is carried by natural drainageways, field drains, or road ditches to streams.

These soils are used primarily for cultivated crops. In some small areas they are used for pasture or hay. They are well suited to cultivated crops. The main concerns in managing cultivated areas are controlling soil blowing and maintaining or improving tilth and fertility.

13. Glyndon-Gardena Association

Very deep, level and nearly level, somewhat poorly drained and moderately well drained, medium textured soils

This association consists of soils on flats on lake plains. A few drainageways cross the association. Slopes range from 0 to 3 percent.

This association makes up about 5 percent of the county. It is about 43 percent Glyndon soils, 30 percent Gardena soils, and 27 percent soils of minor extent.

The level, somewhat poorly drained Glyndon soils are on flats. Typically, the surface layer is black, calcareous loam about 7 inches thick. The subsoil is about 23 inches thick. It is calcareous. It is grayish brown loam in the upper part and light olive brown silt loam in the lower part. The substratum to a depth of about 60 inches is calcareous, mottled silt loam. It is light olive brown in the upper part and light yellowish brown in the lower part.

The level and nearly level, moderately well drained Gardena soils are on the higher flats. Typically, the surface soil is loam about 17 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 26 inches thick. It is very dark grayish brown loam in the upper part, dark brown very fine sandy loam in the next part, and light olive brown, calcareous silt loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam.

Embden, Lamoure, Overly, and Zell are the minor soils in this association. Embden and Overly soils are intermingled with areas of the Gardena soils. Embden soils have a higher content of fine sand and a lower content of very fine sand and silt than the Gardena soils. Overly soils have a higher content of clay and a lower content of very fine sand and silt than the Gardena soils. The poorly drained Lamoure soils are on flood plains. The well drained Zell soils are on shoulder slopes and summits.

Most areas are used for cultivated crops. A few are used for hay or pasture. This association is well suited to small grain, corn, soybeans, and sunflowers. Controlling soil blowing on the Glyndon soils is the main concern in managing cultivated areas.

14. Overly-Bearden Association

Very deep, level and nearly level, moderately well drained and somewhat poorly drained, moderately fine textured soils

This association consists of soils on flats on lake plains. Slopes range from 0 to 3 percent.

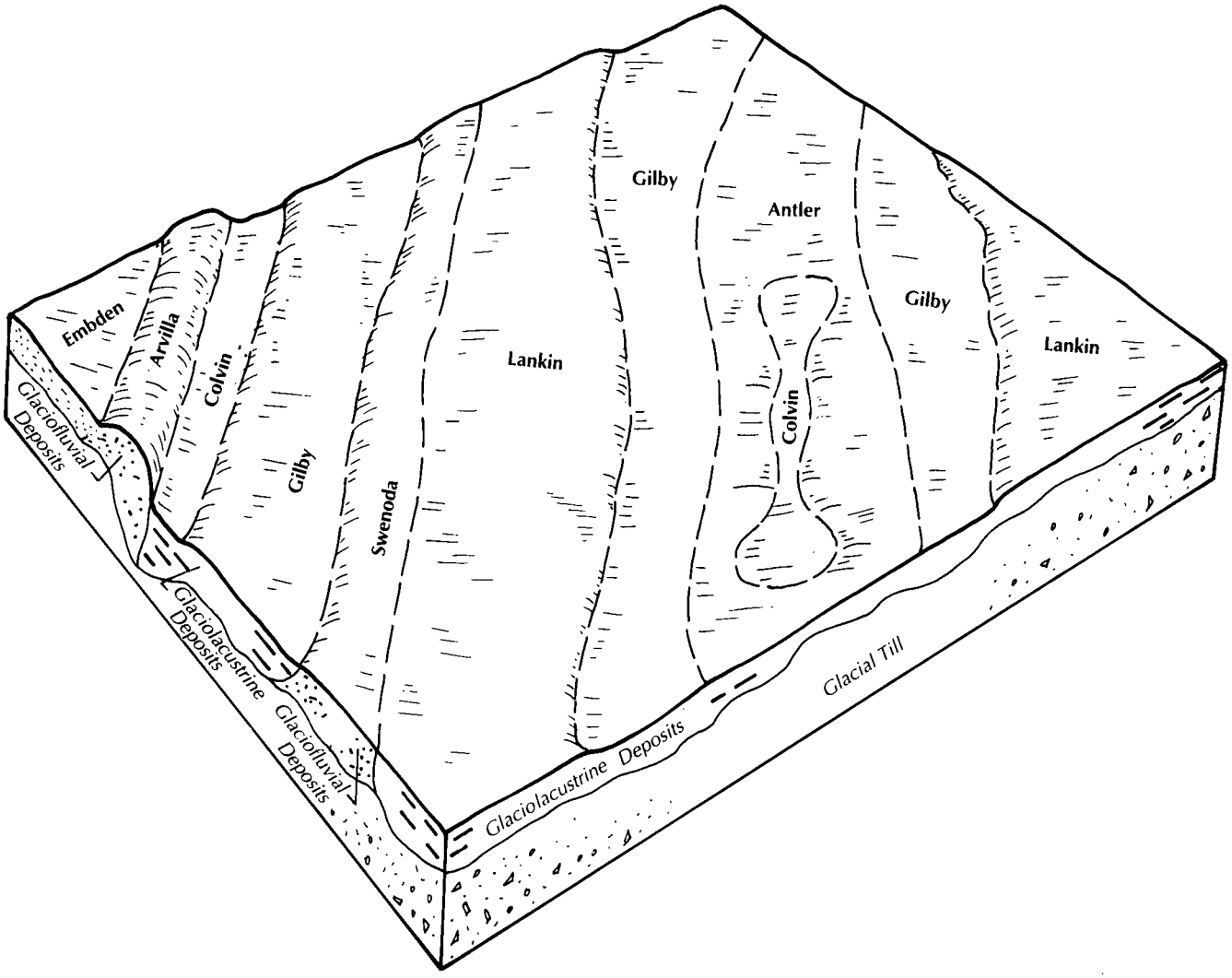

Figure 7.—Typical pattern of soils and parent material in the Lankin-Gilby-Antler association.

This association makes up about 4 percent of the county. It is about 54 percent Overly soils, 21 percent Bearden soils, and 25 percent soils of minor extent.

The level and nearly level, moderately well drained Overly soils are on flats. Typically, the surface soil is silty clay loam about 14 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is silty clay loam about 17 inches thick. It is very dark grayish brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and grayish brown silty clay loam in the upper part; light yellowish brown, mottled silt loam in the next part; and grayish brown and light olive brown, mottled silty clay loam in the lower part.

The level, somewhat poorly drained Bearden soils are on the lower flats. Typically, the surface soil is black, calcareous silty clay loam about 8 inches thick. The next layer is very dark gray, calcareous silty clay loam about 4 inches thick. The subsoil is olive brown, calcareous silty clay loam about 25 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous, and mottled. It is silt loam in the upper part, silty clay loam and silt loam in the next part, and silt loam in the lower part.

Of minor extent in this association are Aberdeen soils, the saline Colvin soils, and Swenoda, Velva, Wyndmere, and Zell soils. Aberdeen and Swenoda soils are intermingled with areas of the Overly soils. Aberdeen soils have a dense, sodic subsoil. Swenoda soils have a surface layer of fine sandy loam. The

poorly drained, saline Colvin soils are on the lower flats. The well drained Velva soils are on flood plains and terraces. Wyndmere soils contain more sand and less clay and silt in the upper part than the Bearden and Overly soils. They are intermingled with areas of the Bearden soils. The well drained Zell soils are on shoulder slopes and summits.

Most areas are used for cultivated crops. A few are used for pasture or hay. This association is well suited to small grain, corn, soybeans, and sunflowers. Controlling soil blowing on the Bearden soils is the main concern in managing cultivated areas.

15. Lankin-Gilby-Antler Association

Very deep, level, moderately well drained and somewhat poorly drained, medium textured and moderately fine textured soils

This association consists of soils on flats on lake plains. Slopes are 0 to 1 percent.

This association makes up about 7 percent of the county. It is about 29 percent Lankin soils, 28 percent Gilby soils, 12 percent Antler soils, and 31 percent soils of minor extent (fig. 7).

The moderately well drained Lankin soils are on flats. Typically, the surface soil is black loam about 10 inches thick. The subsoil is about 22 inches thick. In sequence downward, it is very dark brown loam; very dark grayish brown loam; light yellowish brown, calcareous loam; and light yellowish brown, calcareous clay loam. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is loam in the upper part and clay loam in the lower part.

The somewhat poorly drained Gilby soils are on the lower flats. Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is about 38 inches thick. It is calcareous. In sequence downward, it is grayish brown loam, light brownish gray loam, light olive brown loam, and light olive brown, mottled clay loam. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous clay loam.

The somewhat poorly drained Antler soils are on the lower flats. Typically, the surface layer is black, calcareous clay loam about 9 inches thick. The subsoil is about 35 inches thick. It is calcareous. It is dark gray clay loam in the upper part, grayish brown clay loam in the next part, and light olive brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous loam.

Arvilla, Colvin, Embden, Lamoure, Swenoda, and Velva are the minor soils in this association. The somewhat excessively drained Arvilla soils are on beach ridges. The poorly drained Colvin soils are on the lower flats. Embden and Swenoda soils have a surface soil of fine sandy loam. They are intermingled with areas of the Lankin soils. The poorly drained Lamoure soils are in drainageways. The well drained Velva soils are on flood plains.

Most areas are used for cultivated crops. A few are used for pasture or hay. This association is well suited to small grain, corn, soybeans, and sunflowers. Controlling soil blowing on the Gilby and Antler soils and maintaining or improving tilth and fertility in the Lankin soils are the main concerns in managing cultivated areas.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under the heading "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Hamerly loam, 3 to 6 percent slopes, is a phase of the Hamerly series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Barnes-Svea loams, 3 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Vallers and Hamerly loams, saline, 0 to 3 percent slopes, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

As a result of changes in series concepts, differing soil patterns, and differences in the design of the map units, some of the soil boundaries and soil names on the detailed soil maps of this county do not match those on the maps of Barnes, Cass, Grand Forks, Griggs, Nelson, and Traill Counties.

The map unit descriptions indicate some of the pasture grasses and legumes that are suited to the soils in the county. A more extensive list is included in the descriptions of pasture groups in the section "Crops and Pasture."

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

9—Aberdeen silty clay loam. This very deep, level, moderately well drained, sodic soil is on flats on lake

plains. Individual areas range from about 10 to 120 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The next layer is very dark grayish brown and dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 27 inches thick. It is dense. It is very dark grayish brown silty clay in the upper part, dark grayish brown silty clay in the next part, and light olive brown, calcareous silty clay loam in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light yellowish brown, mottled silty clay loam in the upper part and light olive brown, mottled, stratified silt loam, silty clay loam, and very fine sandy loam in the lower part.

Included with this soil in mapping are small areas of Overly, Perella, and Swenoda soils. Also included are a few small areas of somewhat poorly drained, highly calcareous, saline soils. Included soils make up about 5 to 20 percent of the unit. They do not have a dense, sodic subsoil. Overly and Swenoda soils are intermingled with areas of the Aberdeen soil. The somewhat poorly drained Perella soils are in swales.

Permeability is slow in the Aberdeen soil. Runoff is very slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity and organic matter content are high. Tilth is fair. The dense, sodic subsoil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. This soil is suited to small grain, sunflowers, and alfalfa. The main concerns in managing cultivated areas are maintaining or improving tilth and improving root penetration in the dense, sodic subsoil. Crops growing on this soil typically appear stunted because of moisture stress. The hazards of soil blowing and water erosion are slight. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain or improve tilth and increase the rate of water infiltration. Growing deep-rooted legumes, such as alfalfa, improves root penetration in the dense, sodic subsoil. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Russian wildrye, western wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of this soil for pasture.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil and the reduced amount of available water caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIIs. The productivity index for spring wheat is 73. The pasture group is Clayey Subsoil.

43—Antler clay loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from about 15 to 500 acres in size.

Typically, the surface layer is black, calcareous clay loam about 9 inches thick. The subsoil is about 35 inches thick. It is calcareous. It is dark gray clay loam in the upper part, grayish brown clay loam in the next part, and light olive brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some places the surface layer and the upper part of the subsoil are loam. In other places the soil contains more silt and less sand.

Included with this soil in mapping are small areas of Divide, Perella, Tonka, Vallers, and Wyard soils. Also included are small areas of somewhat poorly drained soils that have accumulated clay in the subsoil. Included soils make up about 5 to 25 percent of the unit. Divide soils have a substratum of sand and gravel at a depth of 20 to 40 inches. They are intermingled with areas of the Antler soil. Perella and Wyard soils do not have lime within a depth of 20 inches. They are in swales. Tonka and Vallers soils are poorly drained. Tonka soils are in depressions, and Vallers soils are on the lower flats.

Permeability is moderately slow in the Antler soil. Runoff is very slow. A seasonal high water table is at a depth of 1 to 4 feet. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops. A few are used for pasture or hay. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concerns in managing cultivated areas are controlling soil blowing and maintaining or improving tilth. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Switchgrass, big bluestem, tall wheatgrass, and

sweetclover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 89. The pasture group is Limy Subirrigated.

64—Arveson loam. This very deep, level, poorly drained, highly calcareous soil is on flats and in swales on delta plains. Individual areas range from about 3 to 400 acres in size.

Typically, the surface soil is black, calcareous loam about 11 inches thick. The next layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is dark gray, calcareous fine sandy loam about 8 inches thick. The substratum to a depth of about 60 inches is calcareous. It is grayish brown fine sandy loam in the upper part and olive gray, mottled fine sand in the lower part. In some places lime is below a depth of 20 inches. In other places the subsoil and substratum contain more sand and less clay. In some areas the soil contains more silt and less sand throughout. In a few areas the substratum contains more clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Wyndmere soils on the higher flats. Also included are small areas of very poorly drained soils in depressions. Included soils make up about 1 to 10 percent of the unit.

Permeability is moderate in the upper part of the Arveson soil and rapid in the lower part. Runoff is very slow. A seasonal high water table is within a depth of 2 feet. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. If drained, this soil is suited to small grain and sunflowers. Undrained areas, however, are poorly suited to these crops. The main concerns in managing cultivated areas are reducing wetness and controlling soil blowing. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas wetness frequently delays tillage and seeding. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Tillage at the proper soil moisture content helps to prevent surface compaction.

Creeping foxtail, big bluestem, switchgrass, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIw. The productivity index for spring wheat ranges from 31 to 60, depending on the degree of drainage. The pasture group is Wet.

76—Arvilla sandy loam, 0 to 6 percent slopes. This very deep, level to undulating, somewhat excessively drained soil is on beach ridges on delta plains. Individual areas range from about 15 to 350 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsoil is about 20 inches thick. It is very dark brown sandy loam in the upper part, dark yellowish brown sandy loam in the next part, and grayish brown, calcareous gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is grayish brown, calcareous gravelly coarse sand. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil and substratum are fine sand and have less than 5 percent gravel. In a few areas more than 20 percent of the gravel in the substratum is shale.

Included with this soil in mapping are small areas of well drained soils that are sandy loam or fine sandy loam to a depth of 25 to 35 inches. Also included, on knolls and ridges, are small areas of excessively drained soils that have a substratum of sand and gravel within a depth of 12 inches. Included soils make up about 5 to 20 percent of the unit.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is very slow. Available water capacity is low. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. Some are

used for pasture or hay. This soil is very poorly suited to small grain, corn, soybeans, and sunflowers. It is best suited to pasture and hay. Rye and winter wheat make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, buffer strips, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the early season moisture supply. Because of the low available water capacity, fallowing is of limited value. It increases the susceptibility to soil blowing. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Crested wheatgrass, western wheatgrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 42. The pasture group is Shallow to Gravel.

118—Barnes-Buse loams, 3 to 6 percent slopes. These very deep, undulating, well drained soils are on rises on till plains. The Barnes soil is on side slopes. The Buse soil is on shoulder slopes and summits. Individual areas range from about 10 to more than 500 acres in size. They are about 45 to 70 percent Barnes soil and 25 to 50 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil contains more clay.

Typically, the Buse soil has a surface layer of very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part. In some places the surface layer is dark grayish brown and is eroded. In other places the soil contains less clay and more sand.

Included with these soils in mapping are small areas of Hamerly, Parnell, Tonka, and Vallers soils. Also included are some gently rolling areas. Included soils make up about 1 to 10 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in shallow depressions. The poorly drained Vallers soils are on low flats.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are well suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is moderate on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, buffer strips, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer

help to maintain tilth and increase the rate of water infiltration in the Buse soil.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 66. The pasture group of the Barnes soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

120—Barnes-Buse loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on knolls and ridges on till plains. The Barnes soil is on side slopes. The Buse soil is on shoulder slopes and summits. Individual areas range from about 5 to 150 acres in size. They are about 40 to 65 percent Barnes soil and 30 to 55 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil contains more clay.

Typically, the Buse soil has a surface layer of very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part. In some places the surface layer is dark grayish brown and is eroded. In other places the soil contains less clay and more sand.

Included with these soils in mapping are small areas of Brantford, Coe, Hamerly, Lamoure, Parnell, Tonka, and Wyard soils. Also included are some rolling areas. Included soils make up about 1 to 10 percent of the unit. Brantford and Coe soils are intermingled with areas of the Buse soil. Brantford soils have a substratum of sand and gravel. Coe soils are excessively drained. Hamerly and Wyard soils are somewhat poorly drained. Hamerly soils are on flats, and Wyard soils are in swales. Lamoure and Tonka soils are poorly drained. Lamoure soils are in drainageways, and Tonka soils are in shallow depressions. Parnell soils are very poorly drained and are in deep depressions.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is rapid. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are poorly suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is severe on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, buffer strips, and grassed waterways in areas where runoff concentrates help to control erosion (fig. 8). Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration in the Buse soil.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and

Figure 8.—Grassed waterways in an area of Barnes-Buse loams, 6 to 9 percent slopes.

growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Barnes soil is IIIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 50. The pasture group of the Barnes soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

156—Barnes-Svea loams, 3 to 6 percent slopes. These very deep, undulating soils are on rises on till plains. The well drained Barnes soil is on summits. The moderately well drained Svea soil is on foot slopes. Individual areas range from about 10 to 2,000 acres in size. They are about 40 to 65 percent Barnes soil and 20 to 45 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam. In places the subsoil contains more clay.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In places the subsoil contains more clay.

Included with these soils in mapping are small areas of Buse, Hamerly, Parnell, Tonka, and Wyard soils.

These included soils make up about 5 to 20 percent of the unit. Buse soils have a subsoil that is calcareous throughout. They are on knolls and ridges. The somewhat poorly drained Hamerly soils are on flats. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in shallow depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is medium. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are well suited to small grain (fig. 9), corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling water erosion. The hazard of soil blowing is slight on both soils, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration.

Smooth bromegrass, intermediate wheatgrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index of the unit for spring wheat is 83. The pasture group is Loamy and Silty.

189—Bearden-Perella silty clay loams. These very deep, level, somewhat poorly drained soils are on lake plains. The highly calcareous Bearden soil is on flats. The Perella soil is in swales. Individual areas range from about 15 to 700 acres in size. They are about 60 to 80 percent Bearden soil and 10 to 30 percent Perella soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Bearden soil has a surface layer of black, calcareous silty clay loam about 8 inches thick. The next layer is very dark gray, calcareous silty clay loam about 4 inches thick. The subsoil is olive brown, calcareous silty clay loam about 25 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is silt loam in the upper part, silty clay loam and silt loam in the next part, and silt loam in the lower part. In some places the soil has more silt and less clay throughout. In other places the surface layer is silt loam.

Typically, the Perella soil has a surface soil of black silty clay loam about 13 inches thick. The subsoil is mottled silty clay loam about 29 inches thick. It is very dark gray in the upper part, olive and calcareous in the next part, and light yellowish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous silty clay loam and silt loam. In some places the soil is poorly drained. In other places the surface soil is silt loam.

Included with this soil in mapping are small areas of Colvin, Overly, and Tiffany soils and a few small areas of somewhat poorly drained, saline soils. Also included, in depressions, are a few small areas of poorly drained soils that have accumulated clay in the subsoil. Included soils make up about 1 to 15 percent of the unit. The poorly drained Colvin soils are on low flats. The moderately well drained Overly soils are on the slightly higher flats. The poorly drained Tiffany soils are intermingled with areas of the Perella soil.

Permeability is moderately slow in the Bearden and Perella soils. Runoff is very slow. A seasonal high water table is at a depth of 2 to 4 feet in both soils. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, soybeans, and sunflowers. The main concerns in managing cultivated areas are controlling soil blowing and maintaining or improving tilth. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate on the Bearden soil and slight on the Perella soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain or improve tilth and increase the rate of water infiltration. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Switchgrass, big bluestem, tall wheatgrass, and

Figure 9.—An undulating area of Barnes-Svea loams, 3 to 6 percent slopes, planted to spring wheat.

sweetclover are suitable hay and pasture plants. Soil blowing is a hazard on the Bearden soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Bearden soil is IIe, and that of the Perella soil is IIc. The productivity index of the unit for spring wheat is 92. The pasture group of the Bearden soil is Limy Subirrigated, and that of the Perella soil is Wet.

296—Brantford loam, 0 to 3 percent slopes. This very deep, level and nearly level, well drained soil is on flats on outwash plains and terraces. Individual areas range from about 3 to 200 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is about 20 inches thick. It is very dark grayish brown loam in the upper part, dark grayish brown gravelly sandy loam in the next part, and very dark grayish brown, calcareous very gravelly loamy coarse sand in the lower part. The substratum to a depth of about 60 inches is dark grayish brown and calcareous. It is very gravelly coarse sand in the upper part and gravelly sand in the lower part. In some places

the substratum of sand and gravel is at a depth of 20 to 30 inches. In other places the surface layer and the upper part of the subsoil have less clay and more sand. In some areas the substratum has less than 15 percent gravel.

Included with this soil in mapping are small areas of Coe and Divide soils. Also included are a few small areas of moderately well drained soils. Included soils make up about 1 to 10 percent of the unit. The excessively drained Coe soils are intermingled with areas of the Brantford soil. The somewhat poorly drained Divide soils are on the lower flats.

Permeability is moderate in the upper part of the Brantford soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is poorly suited to small grain, corn, soybeans, and sunflowers. Rye and winter wheat make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concern in managing cultivated areas is overcoming droughtiness. The hazards of soil blowing and water erosion are slight, but soil blowing occurs during some windstorms. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the early season moisture supply. Because of the low available water capacity, fallowing is of limited value. It increases the susceptibility to soil blowing. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Crested wheatgrass, western wheatgrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. Local soil blowing and droughtiness are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIIs. The productivity index for spring wheat is 50. The pasture group is Shallow to Gravel.

314—Buse-Barnes loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on knolls and ridges on till plains. The Buse soil is on shoulder slopes and summits. The Barnes soil is on side slopes. Individual areas range from about 10 to 150 acres in size. They are about 40 to 65 percent Buse soil and 25 to 50 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a surface layer of very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part. In some places the surface layer is dark grayish brown and is eroded. In other places the soil contains less clay and more sand.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam. In some places the surface layer is very dark grayish brown and is eroded. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the subsoil contains more clay. In other areas the soil contains less clay and more sand.

Included with these soils in mapping are small areas of Coe, Hamerly, Lamoure, Maddock, Tonka, and Wyard soils. Also included are some hilly areas. Included soils make up about 1 to 15 percent of the unit. The excessively drained Coe soils are intermingled with areas of the Buse soil. The somewhat poorly drained Hamerly soils are on flats. The poorly drained Lamoure soils are in drainageways. Maddock soils are sandy throughout. They are intermingled with areas of the Buse soil. The poorly drained Tonka soils are in

depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderately slow in the Buse and Barnes soils. Runoff is rapid. Available water capacity is high. Organic matter content is moderately low in the Buse soil and high in the Barnes soil.

Most areas are used for cultivated crops. Some are used for pasture, hay, or range. These soils are best suited to pasture, hay, and range. They are generally unsuited to cultivated crops because of a severe hazard of water erosion on both soils, a moderate hazard of soil blowing on the Buse soil, and the slope of both soils. Returning cultivated areas to a cover of grasses and legumes helps to control erosion.

In areas where these soils are used for range, the important forage plants are little bluestem, western wheatgrass, needleandthread, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Buse soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Barnes soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Buse soil is VIe, and that of the Barnes soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty. The pasture group of the Buse soil is Thin Upland, and that of the Barnes soil is Loamy and Silty.

319—Buse-Barnes loams, 15 to 35 percent slopes. These very deep, well drained soils are on knolls and ridges on till plains. The hilly and steep Buse soil is on summits and shoulder slopes. The hilly Barnes soil is on side slopes. Individual areas range from about 10 to 900 acres in size. They are about 40 to 65 percent Buse soil and 30 to 55 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a surface layer of very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part. In some places the surface layer is dark grayish brown and is eroded. In other places the soil contains less clay and more sand. In some areas it contains less clay and sand and more silt.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam. In some places the surface layer is very dark grayish brown and is eroded. In other places the soil contains less clay and more sand. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Coe, Lamoure, and Maddock soils. Also included are some gently rolling and rolling areas and a few stony areas. Included soils make up about 1 to 10 percent of the unit. The excessively drained Coe soils are intermingled with areas of the Buse soil. The poorly drained Lamoure soils are in drainageways. Maddock soils are sandy throughout. They are intermingled with areas of the Barnes soil.

Permeability is moderately slow in the Buse and Barnes soils. Runoff is very rapid. Available water capacity is high. Organic matter content is moderately low in the Buse soil and high in the Barnes soil.

Most areas are used for range (fig. 10) or wildlife habitat. Some are used for cultivated crops, pasture, or hay. These soils are best suited to range and wildlife habitat. They are generally unsuited to cultivated crops and pasture because of a moderate hazard of soil blowing, a very severe hazard of water erosion, and the slope. Returning cultivated areas to a cover of grasses and legumes helps to control erosion.

The important range plants on these soils are little bluestem, western wheatgrass, and needleandthread. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be

Figure 10.—An area of Buse-Barnes loams, 15 to 35 percent slopes, on side slopes near the Sheyenne River. These soils are best suited to range.

grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Buse soil is VIIe, and that of the Barnes soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty.

391—Cavour-Cresbard loams, 0 to 3 percent slopes. These very deep, level and nearly level, moderately well drained, sodic soils are on till plains. The Cavour soil is on flats. The Cresbard soil is on rises. Individual areas range from about 3 to 300 acres in size. They are about 30 to 55 percent Cavour soil and 25 to 50 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cavour soil has a surface layer of black loam about 6 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The subsoil is about 49 inches thick. It is very dark gray clay loam in the upper part; dark grayish brown, calcareous clay loam in the next part; and light olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In places the soil has salts at a depth of 10 to 16 inches. In a few areas the subsoil is underlain by weathered shale bedrock.

Typically, the Cresbard soil has a surface layer of black loam about 8 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The next layer is black and very dark gray clay loam about 2 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam; dark grayish brown clay loam; light olive brown,

calcareous clay loam; and light olive brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam.

Included with these soils in mapping are small areas of Barnes and Edgeley soils; the nonsaline and saline Hamerly soils; and Svea, Tonka, and Wyard soils. These included soils make up about 10 to 30 percent of the unit. The well drained Barnes and Edgeley soils are on rises. The somewhat poorly drained Hamerly soils are on low flats. Svea soils do not have a sodic subsoil. They are on rises. The poorly drained Tonka soils are in depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is slow in the Cavour and Cresbard soils. Runoff also is slow. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Available water capacity is moderate in the Cavour soil and high in the Cresbard soil. Organic matter content is high in both soils. Tilth is poor in the Cavour soil and fair in the Cresbard soil. The dense, sodic subsoil in both soils restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. Some are used for pasture or hay. These soils are poorly suited to small grain and sunflowers. They are better suited to pasture and hay. The main concerns in managing cultivated areas are maintaining or improving tilth and improving root penetration in the dense, sodic subsoil of both soils. Crops growing on these soils typically appear stunted because of moisture stress. The hazards of soil blowing and water erosion are slight. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain or improve tilth and increase the rate of water infiltration. Growing deep-rooted legumes, such as alfalfa, improves root penetration in the dense, sodic subsoil. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Western wheatgrass, slender wheatgrass, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. The dense, sodic subsoil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to prevent denuding. Stock water ponds constructed in areas of these soils sometimes contain salty water.

The Cavour soil is suited to only a few of the drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Supplemental watering helps to ensure the survival of seedlings. The Cresbard soil is suited to many of the climatically adapted species. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil in both soils and the reduced amount of available water caused by the salts in the Cavour soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Cavour soil is IVs, and that of the Cresbard soil is IIIs. The productivity index of the unit for spring wheat is 59. The pasture group of the Cavour soil is Claypan, and that of the Cresbard soil is Clayey Subsoil.

450—Colvin silt loam. This very deep, level, poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from about 5 to 350 acres in size.

Typically, the surface layer is black, calcareous silt loam about 8 inches thick. The next layer is very dark gray, calcareous silty clay loam about 4 inches thick. The subsoil is gray, calcareous silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is calcareous and mottled. It is olive gray silty clay loam in the upper part, light olive gray silt loam in the next part, and pale olive silty clay loam and silt loam in the lower part. In some places the soil contains less clay. In other places the surface layer is silty clay loam. In some areas the substratum is loam or clay loam. In a few areas the soil contains more sand and less silt.

Included with this soil in mapping are small areas of Arveson, Bearden, and Marysland soils. These soils make up about 1 to 10 percent of the unit. Arveson and Marysland soils are intermingled with areas of the Colvin soil. Arveson soils contain more sand and less clay than the Colvin soil. Marysland soils have a substratum of sand and gravel at a depth of 20 to 40 inches. The somewhat poorly drained Bearden soils are on the higher flats.

Permeability is moderately slow in the Colvin soil. Runoff is very slow. A seasonal high water table is within a depth of 1 foot. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. If drained, this soil is suited to small grain and sunflowers. Undrained areas, however, are poorly suited to these crops. The main concerns in managing cultivated areas are reducing wetness and controlling soil blowing. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas wetness frequently delays tillage and seeding. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of

conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration. Tillage at the proper soil moisture content helps to prevent surface compaction.

Creeping foxtail, big bluestem, switchgrass, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIw. The productivity index for spring wheat ranges from 40 to 70, depending on the degree of drainage. The pasture group is Wet.

452—Colvin silt loam, saline. This very deep, level, poorly drained, highly calcareous, moderately saline soil is on flats on lake plains. Individual areas range from about 15 to 300 acres in size.

Typically, the surface layer is black, calcareous silt loam about 8 inches thick. The next layer is very dark gray, calcareous silty clay loam about 4 inches thick. The subsoil is gray, calcareous silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is calcareous and mottled. It is olive gray silty clay loam in the upper part, light olive gray silt loam in the next part, and pale olive silty clay loam and silt loam in the lower part. In some places the surface layer is silty clay loam. In other places the soil contains less clay and more silt. In some areas it is somewhat poorly drained. In other areas the substratum is loam or clay loam below a depth of 40 inches.

Included in mapping are small areas of soils that contain more sand and less clay than the Colvin soil. Also included are a few small areas of strongly saline soils. Included soils make up about 5 to 20 percent of the unit.

Permeability is moderately slow in the Colvin soil. Runoff is very slow. A seasonal high water table is within a depth of 2 feet. Available water capacity is moderate. Salts reduce the amount of water available to plants. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is best suited to hay, pasture, and wildlife habitat. It is poorly suited to cultivated crops because of wetness and salinity. The main concerns in managing cultivated areas are overcoming salinity, reducing wetness, and controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. In undrained areas wetness delays or prevents tillage and seeding in some years. Fallowing should be avoided because it can result in an increased accumulation of salts in the surface layer. Growing salt-tolerant crops, such as barley, helps to overcome the salinity. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and cover crops help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Alkali sacaton, tall wheatgrass, western wheatgrass, and sweetclover are suitable hay and pasture plants. The hazard of soil blowing, the high content of salts, and the reduced amount of water available to plants are problems, especially if the pasture is overgrazed. Maintaining an adequate cover of salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water resulting from the salts in the soil. Reducing the evaporation rate at the surface increases the seedling survival rate. If the surface is bare as the soil becomes dry, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 21 to 35, depending on the degree of drainage. The pasture group is Saline.

511—Divide loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on outwash plains and

terraces. Individual areas range from about 3 to 400 acres in size.

Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is about 17 inches thick. It is grayish brown and calcareous. It is loam in the upper part and gravelly sandy loam in the lower part. The substratum to a depth of about 60 inches is grayish brown and calcareous. It is mottled very gravelly coarse sand in the upper part and sand in the lower part. In some places the soil has a layer of accumulated lime at a depth of more than 16 inches. In other places the surface layer and subsoil contain more sand and less clay. In some areas depth to the substratum of sand and gravel is less than 20 inches. In a few areas the soil has a substratum of loam below a depth of 40 inches.

Included with this soil in mapping are small areas of Glyndon, Hamerly, and Marysland soils. Also included are small areas of saline soils. Included soils make up about 5 to 20 percent of the unit. Glyndon and Hamerly soils are intermingled with areas of the Divide soil. Glyndon soils have a substratum of silt loam, and Hamerly soils have a substratum of loam. The poorly drained Marysland soils are on the lower flats.

Permeability is moderate in the upper part of the Divide soil and rapid in the lower part. Runoff is slow. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is suited to small grain and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Switchgrass, big bluestem, tall wheatgrass, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 62. The pasture group is Limy Subirrigated.

539—Edgeley loam, 0 to 3 percent slopes. This moderately deep, level and nearly level, well drained soil is on flats on till plains. Individual areas range from about 8 to 250 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 20 inches thick. It is dark brown in the upper part, dark grayish brown and calcareous in the next part, and light olive brown and calcareous in the lower part. The substratum extends to a depth of about 36 inches. It is grayish brown, calcareous loam. Below this is dark grayish brown, weathered shale bedrock. In some places the weathered shale bedrock is at a depth of 40 to 60 inches. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In a few areas the subsoil contains more clay.

Included with this soil in mapping are small areas of Barnes and Cresbard soils, the saline Hamerly soils, and Kloten and Svea soils. These soils make up about 5 to 20 percent of the unit. Barnes, Cresbard, Kloten, and Svea soils are intermingled with areas of the Edgeley soil. Barnes, Cresbard, and Svea soils are very deep. Cresbard and Svea soils are moderately well drained. Kloten soils have weathered shale bedrock within a depth of 20 inches. The somewhat poorly drained, saline Hamerly soils are on the lower flats.

Permeability is moderate in the Edgeley soil. Runoff is slow. Available water capacity is moderate. Organic matter content is high. Tilth is good. The weathered shale bedrock restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. A few are used for pasture or hay. This soil is suited to small grain and sunflowers. The main concern in managing cultivated areas is maintaining tilth and fertility. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and improve fertility.

Smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable hay and

pasture plants. No critical limitations affect the use of this soil for pasture.

This soil is suited to nearly all the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 79. The pasture group is Moderately Deep Silty.

569—Embden fine sandy loam. This very deep, level, moderately well drained soil is on flats on delta plains. Individual areas range from about 10 to 350 acres in size.

Typically, the surface soil is black fine sandy loam about 10 inches thick. The subsoil is fine sandy loam about 26 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The upper part of the substratum is olive brown fine sandy loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled, calcareous loamy fine sand. In some places the soil is well drained and is dark to a depth of less than 16 inches. In other places it has a higher content of very fine sand and silt and a lower content of fine sand. In some areas the subsoil and substratum are sandy throughout. In other areas the surface soil is loam. In a few areas the substratum is loam, silt loam, or silty clay loam below a depth of 40 inches.

Included with this soil in mapping are small areas of Perella, Tiffany, and Wyndmere soils. These soils make up about 1 to 15 percent of the unit. The somewhat poorly drained Perella soils are in swales. The poorly drained Tiffany soils are in depressions. The somewhat poorly drained Wyndmere soils are on the lower flats.

Permeability is moderately rapid in the Embden soil. Runoff is very slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is suited to small grain, corn, soybeans, and sunflowers. Rye and winter wheat make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are controlling soil blowing and overcoming slight droughtiness. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 75. The pasture group is Sandy.

579—Embden-Egeland fine sandy loams, 1 to 6 percent slopes. These very deep, nearly level and undulating soils are on delta plains. The moderately well drained Embden soil is on flats. The well drained Egeland soil is on rises. Individual areas range from about 5 to 130 acres in size. They are about 30 to 55 percent Embden soil and 25 to 50 percent Egeland soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Embden soil has a surface soil of black fine sandy loam about 10 inches thick. The subsoil is fine sandy loam about 26 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The upper part of the substratum is olive brown fine sandy loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled, calcareous loamy fine sand. In some places the lower part of the subsoil and the substratum have more clay and less sand. In other places the surface soil is loam.

Typically, the Egeland soil has a surface layer of very dark gray fine sandy loam about 8 inches thick. The subsoil is fine sandy loam about 21 inches thick. It is olive brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous. It is olive brown fine sandy loam in the upper part, light olive brown very fine

sandy loam and silt loam in the next part, and olive brown loamy fine sand in the lower part. In some places the lower part of the subsoil and the substratum have more clay and less sand. In other places the surface layer is loam.

Included with these soils in mapping are small areas of Gardena, Maddock, Tiffany, and Wyndmere soils. Also included, on knolls and ridges, are small areas of well drained soils having a subsoil that is calcareous throughout. Included soils make up about 10 to 30 percent of the unit. Gardena soils contain more silt and less sand than the Embden soil. They are intermingled with areas of the Embden soil. Maddock soils are sandy throughout. They are intermingled with areas of the Egeland soil. The poorly drained Tiffany soils are in depressions. The somewhat poorly drained Wyndmere soils are on the lower flats.

Permeability is moderately rapid in the Embden and Egeland soils. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet in the Embden soil. Available water capacity is moderate in both soils. Organic matter content is high in the Embden soil and moderate in the Egeland soil. Tilth is good in both soils.

Most areas are used for cultivated crops. Some are used for pasture or hay. These soils are suited to small grain, corn, soybeans, and sunflowers. Rye and winter wheat make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

The Embden soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Egeland soil is suited to many of the climatically adapted species. It is somewhat droughty, and trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index of the unit for spring wheat is 64. The pasture group is Sandy.

597—Emrick-Heimdal loams, 0 to 3 percent slopes. These very deep, level and nearly level, well drained soils are on rises on till plains. The Emrick soil is on foot slopes. The Heimdal soil is on summits. Individual areas range from about 10 to 700 acres in size. They are about 35 to 60 percent Emrick soil and 30 to 55 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Emrick soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 41 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light yellowish brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some places the soil contains more clay and less sand. In other places it has a sandy substratum below a depth of 40 inches. In some areas it contains less sand and more silt.

Typically, the Heimdal soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 31 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the soil contains more clay and less sand. In other places the surface layer and the upper part of the subsoil are fine sandy loam.

Included with these soils in mapping are small areas of Esmond, Fram, Tiffany, Tonka, and Wyard soils. These included soils make up about 1 to 15 percent of the unit. Esmond soils have a subsoil that is calcareous throughout. They are on knolls. The somewhat poorly drained Fram and Wyard soils are in swales. The poorly drained Tiffany and Tonka soils are in depressions.

Permeability is moderate in the Emrick and Heimdal soils. Runoff is slow. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. A few are

used for pasture or hay. These soils are well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling local erosion. The hazards of soil blowing and water erosion are slight, but soil blowing occurs during some windstorms. A system of conservation tillage that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of these soils for pasture. Maintaining an adequate cover of the suitable plants helps to control local erosion.

The Emrick soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Heimdal soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index of the unit for spring wheat is 84. The pasture group of the Emrick soil is Overflow and Run-on, and that of the Heimdal soil is Loamy and Silty.

605—Esmond-Heimdal loams, 9 to 15 percent slopes. These very deep, rolling, well drained soils are on knolls and ridges on till plains. The Esmond soil is on shoulder slopes and summits. The Heimdal soil is on side slopes. Individual areas range from about 5 to 150 acres in size. They are about 30 to 55 percent Esmond soil and 25 to 50 percent Heimdal soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 19 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the surface layer contains more sand and less clay. In other places the soil has a sandy substratum below a depth of 40 inches. In some areas the soil contains more clay and less sand. In other areas it contains more silt and less sand. In a few areas the surface layer is dark grayish brown and is eroded.

Typically, the Heimdal soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 31 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In places the surface layer and the upper part of the subsoil contain more sand and less clay. In a few areas the soil contains more sand and less clay throughout. In some areas the dark color of the surface layer extends to a depth of more than 16 inches. In other areas the soil contains less sand and more silt. In places the surface layer is very dark grayish brown and is eroded.

Included with these soils in mapping are small areas of Binford, Coe, Svea, and Wyard soils. Also included are some hilly areas. Included soils make up about 5 to 25 percent of the unit. The somewhat excessively drained Binford and excessively drained Coe soils are intermingled with areas of the Esmond soil. The moderately well drained Svea soils are on foot slopes. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderate in the Esmond and Heimdal soils. Runoff is rapid. Available water capacity is high. Organic matter content is moderately low in the Esmond soil and high in the Heimdal soil.

Most areas are used for cultivated crops. Some are used for pasture, hay, or range. These soils are best suited to pasture, hay, and range. They are generally unsuited to cultivated crops because of a severe hazard of erosion and the slope. Returning cultivated areas to a cover of grasses and legumes helps to control erosion.

In areas where these soils are used for range, the important forage plants are little bluestem, western wheatgrass, needleandthread, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Esmond soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Heimdal soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Esmond soil is VIe, and that of the Heimdal soil is IVe. The productivity index of the unit for spring wheat is 0. The

range site of the Esmond soil is Thin Upland, and that of the Heimdal soil is Silty. The pasture group of the Esmond soil is Thin Upland, and that of the Heimdal soil is Loamy and Silty.

753—Fram-Wyard loams, 0 to 3 percent slopes. These very deep, somewhat poorly drained soils are on till plains. The level and nearly level, highly calcareous Fram soil is on flats. The level Wyard soil is in swales. Individual areas range from about 5 to 1,000 acres in size. They are about 50 to 75 percent Fram soil and 15 to 40 percent Wyard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Fram soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 28 inches thick. It is mottled between depths of 21 and 35 inches. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the soil contains more clay and less sand. In other places it contains more silt and less sand. In some areas the lower part of the subsoil and the substratum are silt loam. In a few areas the surface layer and subsoil are fine sandy loam.

Typically, the Wyard soil has a surface soil of loam about 14 inches thick. The surface soil is black in the upper part and very dark gray and mottled in the lower part. The subsoil is mottled loam about 22 inches thick. It is very dark gray in the upper part, dark grayish brown in the next part, and light brownish gray and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In places the soil contains more sand and less clay.

Included with these soils in mapping are small areas of Emrick, Tonka, and Vallers soils. Also included are a few small areas of saline soils. Included soils make up about 1 to 15 percent of the unit. The well drained Emrick soils are on rises. The poorly drained Tonka soils are in depressions. The poorly drained Vallers soils are on the lower flats.

Permeability is moderate in the Fram and Wyard soils. Runoff is slow. Water runs onto the Wyard soil from the higher adjacent areas. A seasonal high water table is at a depth of 2 to 6 feet in the Fram soil and at a depth of 1 to 3 feet in the Wyard soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, soybeans, and sunflowers. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate on the Fram soil and slight on the Wyard soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper moisture content helps to prevent surface compaction.

Switchgrass, big bluestem, tall wheatgrass, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard on the Fram soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Fram soil is IIe, and that of the Wyard soil is IIw. The productivity index of the unit for spring wheat is 84. The pasture group of the Fram soil is Limy Subirrigated, and that of the Wyard soil is Overflow and Run-on.

763—Gardena loam, 0 to 3 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on lake plains. Individual areas range from about 15 to 800 acres in size.

Typically, the surface soil is loam about 17 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 26 inches thick. It is very dark grayish brown loam in the upper part, dark brown very fine sandy loam in the next part, and light olive brown, calcareous silt loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam. In some places the soil is well drained and is dark to a depth of less than 16 inches. In other places the surface soil is silt loam or very fine sandy loam. In some areas the soil contains more clay and less silt.

Included with this soil in mapping are small areas of Embden, Glyndon, and Swenoda soils. These soils make up about 1 to 15 percent of the unit. Embden and Swenoda soils are intermingled with areas of the Gardena soil. Embden soils contain more sand and less silt throughout than the Gardena soil. Swenoda soils

contain more sand and less silt in the surface soil and in the upper part of the subsoil than the Gardena soil. The somewhat poorly drained Glyndon soils are on the lower flats.

Permeability is moderate in the Gardena soil. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazards of soil blowing and water erosion are slight, but soil blowing occurs during some windstorms. A system of conservation tillage that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Smooth bromegrass, intermediate wheatgrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of this soil for pasture. Maintaining an adequate cover of the suitable plants helps to control local erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index for spring wheat is 98. The pasture group is Loamy and Silty.

781—Gilby loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from about 15 to 1,000 acres in size.

Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is about 38 inches thick. It is calcareous. In sequence downward, it is grayish brown loam, light brownish gray loam, light olive brown loam, and light olive brown, mottled clay loam. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous clay loam. In some places the surface layer is fine sandy loam. In other places the soil contains more silt and less sand and clay. In some areas the surface layer and the upper part of the subsoil contain more clay.

Included with this soil in mapping are small areas of Bearden, Divide, Fram, Tonka, Wyard, and Wyndmere soils. These soils make up about 5 to 25 percent of the unit. Bearden, Divide, Fram, and Wyndmere soils are intermingled with areas of the Gilby soil. Bearden soils have a surface layer and subsoil of silty clay loam. Divide soils have a substratum of sand and gravel. Fram soils contain more sand and less clay than the Gilby soil. Wyndmere soils have a surface layer and subsoil of fine sandy loam. The poorly drained Tonka soils are in depressions. Wyard soils do not have lime within a depth of 20 inches. They are in swales.

Permeability is moderately slow in the Gilby soil. Runoff is very slow. A seasonal high water table is at a depth of 1 to 4 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. A few are used for pasture or hay. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Switchgrass, big bluestem, tall wheatgrass, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 92. The pasture group is Limy Subirrigated.

796—Glyndon loam. This very deep, level, somewhat poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from about 5 to 600 acres in size.

Typically, the surface layer is black, calcareous loam about 7 inches thick. The subsoil is about 23 inches thick. It is calcareous. It is grayish brown loam in the

upper part and light olive brown silt loam in the lower part. The substratum to a depth of about 60 inches is mottled, calcareous silt loam. It is light olive brown in the upper part and light yellowish brown in the lower part. In some places the surface layer is loam or very fine sandy loam. In other places the soil contains more sand and less silt. In some areas it contains more clay and less silt. In a few areas the surface layer and the upper part of the subsoil are loam that has about 2 to 10 percent gravel.

Included with this soil in mapping are small areas of Embden, Gardena, and Perella soils. Also included, in depressions, are small areas of poorly drained soils that have accumulated clay in the subsoil. Included soils make up about 5 to 20 percent of the unit. The moderately well drained Embden and Gardena soils are on the higher flats. Perella soils do not have lime within a depth of 16 inches. They are in swales.

Permeability is moderate in the Glyndon soil. Runoff is very slow. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Switchgrass, big bluestem, tall wheatgrass, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 93. The pasture group is Limy Subirrigated.

866—Hamerly loam, 3 to 6 percent slopes. This very deep, undulating, somewhat poorly drained, highly calcareous soil is on rises and along drainageways on till plains. Individual areas range from about 3 to 100 acres in size.

Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 28 inches thick. It is light brownish gray in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some places lime is below a depth of 20 inches. In other places the soil contains more sand and less clay.

Included with this soil in mapping are small areas of Buse, Divide, Parnell, Tonka, and Vallers soils. Also included are small areas of saline soils. Included soils make up about 5 to 20 percent of the unit. Buse soils are well drained and are on knolls. Divide soils have a substratum of sand and gravel. They are intermingled with areas of the Hamerly soil. Parnell soils are very poorly drained, and Tonka and Vallers soils are poorly drained. Parnell and Tonka soils are in depressions, and Vallers soils are on the lower flats.

Permeability is moderately slow in the Hamerly soil. Runoff is medium. A seasonal high water table is at a depth of 2 to 4 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is suited to small grain and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazards of soil blowing and water erosion are moderate. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, buffer strips, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Switchgrass, big bluestem, tall wheatgrass, and sweetclover are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion.

This soil is suited to all of the climatically adapted

trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIe. The productivity index for spring wheat is 72. The pasture group is Limy Subirrigated.

881—Hamerly-Tonka complex, 0 to 3 percent slopes. These very deep soils are on till plains. The somewhat poorly drained, level and nearly level, highly calcareous Hamerly soil is on flats. The poorly drained, level Tonka soil is in depressions. It is subject to ponding. Individual areas range from about 3 to 700 acres in size. They are about 35 to 60 percent Hamerly soil and 25 to 50 percent Tonka soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 28 inches thick. It is light brownish gray in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In places lime is below a depth of 20 inches.

Typically, the Tonka soil has a surface layer of black silt loam about 7 inches thick. The subsurface layer is mottled silt loam about 14 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The subsoil is about 27 inches thick. It is very dark gray, mottled silty clay loam in the upper part and black silty clay in the lower part. The next layer is olive gray, mottled clay loam about 10 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous clay loam. In places the leached subsurface layer is less than 4 inches thick.

Included with these soils in mapping are small areas of Cresbard soils; the saline Hamerly soils; and Marysland, Parnell, Svea, and Vallers soils. Also included are some undulating areas. Included soils make up about 5 to 20 percent of the unit. The moderately well drained Cresbard and Svea soils are on rises. The saline Hamerly soils have accumulated salts in the surface layer and subsoil. They are intermingled with areas of the Hamerly soil. Marysland soils have a substratum of sand and gravel. They are on the lower flats. The very poorly drained Parnell soils are in the deeper depressions. The poorly drained Vallers soils are on the lower flats. They do not have an accumulation of clay in the subsoil.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. A seasonal high water table is at a depth of 2.0 to 4.0 feet in the Hamerly soil and is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for cultivated crops. Some are used for hay, pasture, or wetland wildlife habitat. If the Tonka soil is drained, this unit is well suited to small grain and sunflowers. The main concerns in managing cultivated areas are reducing wetness and controlling soil blowing. Suitable drainage outlets are not readily available. As a result, few areas of the Tonka soil are drained. In undrained areas of the Tonka soil, tillage, seeding, and harvesting are frequently delayed or prevented by ponded surface water and crops are harvested in only about 5 to 7 years out of 10. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Tonka soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration. Tillage at the proper soil moisture content helps to prevent surface compaction.

The Tonka soil and the ponded water provide breeding sites and high-quality invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

Switchgrass, big bluestem, sweetclover, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard on the Hamerly soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing. Compaction, trampling, and root shearing are problems, especially if the pasture is grazed when the Tonka soil is wet. They can be overcome by deferring grazing during wet periods.

The Hamerly soil and drained areas of the Tonka soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tonka soil, however, are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tonka soil are abundant and persistent. Eliminating this ground cover before the

trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly soil is IIe, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat ranges from 62 to 84, depending on the degree of drainage. The pasture group of the Hamerly soil is Limy Subirrigated, and that of the Tonka soil is Wet.

884—Hamerly-Wyard loams, 0 to 3 percent slopes. These very deep, somewhat poorly drained soils are on till plains. The level and nearly level, highly calcareous Hamerly soil is on flats. The level Wyard soil is in swales and depressions. Individual areas range from about 3 to 900 acres in size. They are about 40 to 65 percent Hamerly soil and 20 to 45 percent Wyard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 28 inches thick. It is light brownish gray in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In places the soil contains less clay and more sand.

Typically, the Wyard soil has a surface soil of loam about 14 inches thick. The surface soil is black in the upper part and very dark gray and mottled in the lower part. The subsoil is mottled loam about 22 inches thick. It is very dark gray in the upper part, dark grayish brown in the next part, and light brownish gray and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some areas the dark color of the surface soil extends to a depth of less than 16 inches.

Included with these soils in mapping are small areas of Barnes and Divide soils, the saline Hamerly soils, and Tonka and Vallers soils. Also included are some undulating areas. Included soils make up about 5 to 25 percent of the unit. The well drained Barnes soils are on rises. Divide soils and the saline Hamerly soils are intermingled with areas of the Hamerly soil. Divide soils have a substratum of sand and gravel. The saline Hamerly soils have accumulated salts in the surface layer and subsoil. The poorly drained Tonka soils are in deep depressions. The poorly drained Vallers soils are on the lower flats.

Permeability is moderately slow in the Hamerly soil and moderate in the Wyard soil. Runoff is slow on both soils. Water runs onto the Wyard soil from the higher adjacent areas. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and at a depth of 1 to 3 feet in the Wyard soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for cultivated crops. Some are used for hay, pasture, or wetland wildlife habitat. These soils are well suited to small grain, corn, soybeans, and sunflowers. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Wyard soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration. Tillage at the proper soil moisture content helps to prevent surface compaction.

Switchgrass, slender wheatgrass, big bluestem, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard on the Hamerly soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Hamerly soil is IIe, and that of the Wyard soil is IIw. The productivity index of the unit for spring wheat is 83. The pasture group of the Hamerly soil is Limy Subirrigated, and that of the Wyard soil is Overflow and Run-on.

988—Heimdal-Emrick loams, 3 to 6 percent slopes. These very deep, undulating, well drained soils are on rises on till plains. The Heimdal soil is on summits. The Emrick soil is on foot slopes. Individual areas range from about 5 to 500 acres in size. They are about 45 to 70 percent Heimdal soil and 15 to 40 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 6 inches thick. The subsoil is loam

about 31 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the surface layer has less clay and more sand. In other places the upper part of the subsoil contains more clay. In some areas the soil contains less sand and more silt. In other areas it has a sandy substratum below a depth of 40 inches.

Typically, the Emrick soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 41 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light yellowish brown and calcareous in the lower part. The next layer is light olive brown, calcareous loam about 4 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous loam. In some places the soil contains more clay and less sand. In other places the surface layer and the upper part of the subsoil contain more sand and less clay. In some areas the soil has a sandy substratum below a depth of 40 inches.

Included with these soils in mapping are small areas of Binford, Coe, Esmond, Fram, and Wyard soils. These included soils make up about 5 to 25 percent of the unit. Binford, Coe, and Esmond soils are on knolls. Binford soils are somewhat excessively drained. Coe soils are excessively drained. Esmond soils have a subsoil that is calcareous throughout. Fram and Wyard soils are somewhat poorly drained. Fram soils are on flats, and Wyard soils are in swales.

Permeability is moderate in the Heimdal and Emrick soils. Runoff is medium. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazards of soil blowing and water erosion are slight, but soil blowing occurs during some windstorms. A system of conservation tillage that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain good tilth.

Smooth bromegrass, intermediate wheatgrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of these soils for pasture. Maintaining an adequate cover of the suitable plants helps to control local erosion.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Emrick soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index of the unit for spring wheat is 83. The pasture group is Loamy and Silty.

998—Heimdal-Esmond loams, 6 to 9 percent slopes. These very deep, gently rolling, well drained soils are on knolls and ridges on till plains. The Heimdal soil is on side slopes. The Esmond soil is on shoulder slopes and summits. Individual areas range from about 5 to 200 acres in size. They are about 40 to 65 percent Heimdal soil and 20 to 45 percent Esmond soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Heimdal soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 31 inches thick. It is dark brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the surface layer and the upper part of the subsoil contain more sand and less clay. In other places the soil contains more sand and less clay throughout. In some areas the dark color of the surface layer extends to a depth of more than 16 inches. In other places the soil contains more clay and less sand. In a few places it has a sandy substratum below a depth of 40 inches.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 19 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the surface layer contains more sand and less clay. In other places the soil has a sandy substratum below a depth of 40 inches. In some areas it contains more clay and less sand. In other areas it contains more silt and less sand. In a few areas the surface layer is dark grayish brown and is eroded.

Included with these soils in mapping are small areas of Binford, Coe, Fram, Maddock, Svea, Vallers, and Wyard soils. Also included are some rolling areas and some small areas of well drained soils that have a sandy subsoil. Included soils make up about 5 to 20 percent of the unit. The somewhat excessively drained Binford and excessively drained Coe soils are intermingled with areas of the Esmond soil. The somewhat poorly drained Fram soils are on flats. Maddock soils are sandy throughout. They are intermingled with areas of the Heimdal soil. The moderately well drained Svea soils are on foot slopes.

The poorly drained Vallers soils are on low flats. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderate in the Heimdal and Esmond soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Heimdal soil and moderately low in the Esmond soil. Tilth is good in both soils.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are poorly suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazard of soil blowing is slight on the Heimdal soil and moderate on the Esmond soil. The hazard of water erosion is moderate on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, buffer strips, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing on the Esmond soil and water erosion on both soils are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Heimdal soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Esmond soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Heimdal soil is IIIe, and that of the Esmond soil is IVe. The productivity index of the unit for spring wheat is 47. The pasture group of the Heimdal soil is Loamy and Silty, and that of the Esmond soil is Thin Upland.

1031—Kratka fine sandy loam. This very deep, level, poorly drained soil is on flats on delta plains. Individual areas range from about 5 to 500 acres in size.

Typically, the surface soil is fine sandy loam about 13 inches thick. It is black in the upper part and very dark brown and mottled in the lower part. The substratum to a depth of about 60 inches is mottled. It is light brownish gray loamy fine sand in the upper part and gray, calcareous silty clay loam in the lower part. In some places the upper part of the substratum contains more clay and less sand. In other places the silty part of the substratum is at a depth of more than 40 inches. In some areas the surface soil is loamy fine sand.

Included with this soil in mapping are small areas of somewhat poorly drained, highly calcareous soils on rises. Also included, in depressions, are a few small areas of poorly drained soils that have accumulated clay in the subsoil. Included soils make up about 1 to 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Kratka soil and moderately slow in the lower part. Runoff is very slow. A seasonal high water table is at a depth of 0.5 foot to 3.0 feet. Available water capacity and organic matter content are moderate. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is suited to small grain, soybeans, corn, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Switchgrass, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing

and protect the seedlings from abrasion.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 29 to 61, depending on the degree of drainage. The pasture group is Wet.

1057—LaDelle silt loam, 0 to 3 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on flood plains. It is occasionally flooded. Individual areas range from about 10 to 900 acres in size.

Typically, the surface soil is black silt loam about 20 inches thick. The subsoil is silt loam about 16 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The next layer is very dark grayish brown, calcareous silty clay loam about 2 inches thick. The substratum to a depth of about 60 inches is olive brown, calcareous silt loam. In some places the soil contains more sand and less silt. In other places it contains more silt and less clay.

Included with this soil in mapping are small areas of Lamoure and Velva soils. Also included, on rises and natural levees adjacent to oxbows, are small areas of moderately well drained soils having a surface soil that extends to a depth of less than 16 inches. Included soils make up about 1 to 15 percent of the unit. The poorly drained Lamoure soils are in oxbows. The well drained Velva soils are on natural levees.

Permeability is moderate in the LaDelle soil. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for pasture or hay. Some are used for cultivated crops. This soil is well suited to small grain, corn, soybeans, and sunflowers. Flooding delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The main concern in managing cultivated areas is maintaining tilth and fertility. The hazards of soil blowing and water erosion are slight. A conservation tillage system that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and fertility.

Big bluestem, smooth bromegrass, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Scouring during periods of flooding is a problem, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control scouring.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 98. The pasture group is Overflow and Run-on.

1062—LaDelle silty clay loam, 0 to 3 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on flood plains. It is occasionally flooded. Individual areas range from about 10 to 120 acres in size.

Typically, the surface soil is black silty clay loam about 24 inches thick. The subsoil is very dark grayish brown silty clay loam about 20 inches thick. The next layer is very dark gray, calcareous silty clay loam about 4 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, calcareous silty clay loam. In places the soil contains more sand and less silt. In a few areas it contains more clay and less silt.

Included with this soil in mapping are small areas of Lamoure, Rauville, and Velva soils. Also included, in depressions and oxbows, are small areas of poorly drained soils that contain more clay throughout than the LaDelle soil. Included soils make up about 5 to 20 percent of the unit. The poorly drained Lamoure and very poorly drained Rauville soils are in oxbows. The well drained Velva soils are on natural levees.

Permeability is moderately slow in the LaDelle soil. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for grazeable woodland or for pasture or hay. Some are used for cultivated crops. This soil is well suited to small grain, corn, soybeans, and sunflowers. Flooding delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The main concern in managing cultivated areas is maintaining or improving tilth and fertility. The hazards of soil blowing and water erosion are slight. A conservation tillage system that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and fertility and increase the rate of water infiltration. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Big bluestem, smooth bromegrass, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Scouring during periods of flooding is a problem,

especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control scouring.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 92. The pasture group is Overflow and Run-on.

1092—Lankin loam. This very deep, level, moderately well drained soil is on flats on lake plains. Individual areas range from about 15 to 1,000 acres in size.

Typically, the surface soil is black loam about 10 inches thick. The subsoil is about 22 inches thick. In sequence downward, it is very dark brown loam; very dark grayish brown loam; light yellowish brown, calcareous loam; and light yellowish brown, calcareous clay loam. The substratum to a depth of about 60 inches is light olive brown, mottled, and calcareous. It is loam in the upper part and clay loam in the lower part. In some places the surface soil and the upper part of the subsoil are silty clay loam. In other places the surface soil and subsoil contain more silt and less sand and clay. In some areas the dark color of the surface soil extends to a depth of less than 16 inches. In a few areas the soil contains more silt and less sand throughout.

Included with this soil in mapping are small areas of Emrick, Gilby, Heimdal, Swenoda, Tonka, and Wyard soils. Also included are a few small areas that have few to many small to large stones. Included soils make up about 5 to 25 percent of the unit. The well drained Emrick and Heimdal soils are on rises. The somewhat poorly drained Gilby soils are on the lower flats. Swenoda soils are fine sandy loam in the surface soil and in the upper part of the subsoil. They are intermingled with areas of the Lankin soil. The poorly drained Tonka soils are in depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderately slow in the Lankin soil. Runoff is very slow. A seasonal high water table is at a depth of 3 to 5 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. A few are used for pasture or hay. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is maintaining tilth and fertility. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and fertility.

Smooth bromegrass, intermediate wheatgrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of this soil for pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 95. The pasture group is Loamy and Silty.

1221—Maddock-Hecla loamy fine sands, 1 to 6 percent slopes. These very deep soils are on delta plains. The well drained, nearly level and undulating Maddock soil is on rises. The moderately well drained, nearly level Hecla soil is on flats. Individual areas range from about 5 to 200 acres in size. They are about 55 to 75 percent Maddock soil and 20 to 40 percent Hecla soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Maddock soil has a surface soil of very dark gray loamy fine sand about 11 inches thick. The subsoil is dark brown fine sand about 18 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous fine sand. In some places the surface soil is less than 10 inches thick and is eroded. In other places it is fine sandy loam. In some areas the substratum contains less sand and more clay and silt below a depth of 40 inches. In other areas it is gravelly sand below a depth of 40 inches.

Typically, the Hecla soil has a surface soil of loamy fine sand about 24 inches thick. The surface soil is black in the upper part and very dark gray in the lower part. The next layer is very dark grayish brown fine sand about 7 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is light olive brown in the upper part and olive brown in the lower part. In some places the upper part of the surface soil is fine sandy loam. In other places the substratum contains less sand and more clay and silt below a depth of 40 inches. In a few areas it is gravelly sand below a depth of 40 inches.

Included with these soils in mapping are small areas of the excessively drained Coe soils. Also included are

small areas of somewhat excessively drained soils that are fine sandy loam throughout and have a calcareous surface layer and subsoil. Included soils are on knolls. They make up about 1 to 10 percent of the unit.

Permeability is rapid in the Maddock and Hecla soils. Runoff is very slow. A seasonal high water table is at a depth of 3 to 6 feet in the Hecla soil. Available water capacity is low in both soils. Organic matter content is moderately low. Tilth is fair.

Most areas are used for cultivated crops. Some are used for pasture or hay. These soils are poorly suited to small grain, corn, soybeans, and sunflowers. They are best suited to pasture and hay. Rye and winter wheat make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the early season moisture supply. Because of the low available water capacity of these soils, fallowing is of limited value. It increases the susceptibility to soil blowing. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain or improve tilth. Tillage at the proper soil moisture content also improves tilth.

Switchgrass, prairie sandreed, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

The Maddock soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the season prior to planting. The Hecla soil is suited to all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index of the unit for spring wheat is 39. The pasture group is Sands.

1267—Marysland loam. This very deep, level, poorly drained, highly calcareous soil is on flats on outwash plains. Individual areas range from about 3 to 200 acres in size.

Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 12 inches thick. It is gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is calcareous. It is olive gray, mottled loam in the upper part; olive gray gravelly loamy coarse sand in the next part; and dark gray gravelly loamy coarse sand in the lower part. In some places the substratum contains more clay and less sand below a depth of 40 inches. In other places the soil is somewhat poorly drained. In some areas depth to the substratum of sand and gravel is less than 20 inches. In other areas the depth to lime is more than 16 inches.

Included with this soil in mapping are small areas of Colvin and Vallers soils. Also included are small areas of saline soils and soils that contain less clay and more sand in the surface layer and subsoil than the Marysland soil. Included soils make up about 5 to 20 percent of the unit. They are intermingled with areas of the Marysland soil. Colvin soils have a substratum of silt loam and silty clay loam, and Vallers soils have a substratum of loam.

Permeability is moderate in the upper part of the Marysland soil and rapid in the lower part. Runoff is very slow. A seasonal high water table is within a depth of 2 feet. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops, hay, pasture, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Undrained areas, however, are poorly suited to these crops. Suitable drainage outlets are not readily available. As a result, few areas are drained. In undrained areas tillage, seeding, and harvesting are frequently delayed or prevented by wetness. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and

cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Creeping foxtail, big bluestem, switchgrass, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIw. The productivity index for spring wheat ranges from 30 to 58, depending on the degree of drainage. The pasture group is Wet.

1404—Overly silty clay loam, 0 to 3 percent slopes. This very deep, level and nearly level, moderately well drained soil is on flats on lake plains. Individual areas range from about 15 to 900 acres in size.

Typically, the surface soil is silty clay loam about 14 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is silty clay loam about 17 inches thick. It is very dark grayish brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and grayish brown silty clay loam in the upper part; light yellowish brown, mottled silt loam in the next part; and grayish brown and light olive brown, mottled silty clay loam in the lower part. In some places the soil contains more silt and less clay. In other places the surface layer is silt loam or loam. In some areas the soil is well drained and is dark to a depth of less than 16 inches. In other areas the substratum is loam or clay loam below a depth of 40 inches. In a few areas the upper part of the subsoil contains more clay.

Included with this soil in mapping are small areas of Aberdeen, Bearden, Gardena, Perella, and Swenoda soils. These soils make up about 5 to 20 percent of the unit. Aberdeen, Gardena, and Swenoda soils are intermingled with areas of the Overly soil. Aberdeen soils have a dense, sodic subsoil. Gardena soils have a higher content of very fine sand and a lower content of clay than the Overly soil. Swenoda soils are fine sandy loam in the surface soil and in the upper part of the subsoil. Bearden and Perella soils are somewhat poorly drained. Bearden soils are on the lower flats, and Perella soils are in swales.

Permeability is moderately slow in the Overly soil. Runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops. A few are used for pasture or hay. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is maintaining or improving tilth and fertility. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and fertility and increase the rate of water infiltration. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Smooth bromegrass, intermediate wheatgrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of this soil for pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index for spring wheat is 98. The pasture group is Loamy and Silty.

1427—Parnell silty clay loam. This very deep, level, very poorly drained soil is in depressions on till plains. It is subject to ponding. Individual areas range from about 3 to 30 acres in size.

Typically, the surface soil is black silty clay loam about 12 inches thick. The subsoil is silty clay about 38 inches thick. It is very dark gray in the upper part, very dark gray and mottled in the next part, and dark olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay. In some places the surface soil contains less clay. In other places the soil has carbonates within a depth of 10 inches. In some areas it has a leached subsurface layer.

Included with this soil in mapping are small areas of the poorly drained Vallers soils on flats. These soils make up about 1 to 15 percent of the unit.

Permeability is slow in the Parnell soil. Runoff is ponded. A seasonal high water table is 2 feet above to 2 feet below the surface. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for hay, pasture, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Undrained areas, however, are generally unsuited to these crops. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas, ponding usually prevents tillage, seeding, and harvesting and crops are harvested in only about 1 to 3 years out of 10. The hazards of soil blowing and water erosion are slight.

The soil and the ponded water provide breeding sites and high-quality invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

If this soil is drained, reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the pasture is grazed when wet. They can be overcome by deferring grazing during wet periods.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 22 to 74, depending on the degree of drainage. The pasture group is Wet in drained areas.

1466—Pits, sand and gravel. This unit is in areas from which the soil has been removed and the underlying sand and gravel have been mined. These areas generally support little or no vegetation. They range from about 3 to 50 acres in size.

Many of the pits are abandoned. This unit is generally unsuited to agricultural uses unless it is leveled, topdressed with suitable topsoil, and otherwise reclaimed. In unreclaimed areas planting climatically adapted trees and shrubs can enhance wildlife habitat and increase the esthetic value. The suitability for individual species of trees and shrubs varies from pit to pit.

The land capability classification is VIIIs. The productivity index for spring wheat is 0.

1710—Southam silty clay loam. This very deep, level, very poorly drained, calcareous soil is in depressions on till plains. It is subject to ponding. Individual areas range from about 3 to 300 acres in size.

Typically, the surface soil is about 60 inches thick. It is calcareous. It is black muck in the upper part, black silty clay loam in the next part, and very dark gray, mottled silty clay in the lower part. In places the soil does not have lime throughout.

Included with this soil in mapping are small areas of the poorly drained, saline Vallers soils on flats and small areas of water in the deepest parts of the depressions. Also included, near the edges of the depressions, are small areas of very poorly drained soils that contain less clay and more sand throughout than the Southam soil. Included areas make up about 1 to 15 percent of the unit.

Permeability is slow in the Southam soil. Runoff is ponded. A seasonal high water table is 5 feet above to 1 foot below the surface. Available water capacity is high. Organic matter content is very high.

Most areas of this soil are used for wetland wildlife habitat. The soil is best suited to this use. It is generally unsuited to cultivated crops, pasture, hay, trees, and shrubs because of the ponding. Locating suitable drainage outlets is difficult. As a result, few areas are drained.

The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are controlling siltation and maintaining the natural water level.

The land capability classification is VIIIw. The productivity index for spring wheat is 0.

1762—Svea-Barnes loams, 0 to 3 percent slopes. These very deep, level and nearly level soils are on rises on till plains. The moderately well drained Svea soil is on foot slopes. The well drained Barnes soil is on summits. Individual areas range from about 15 to 350 acres in size. They are about 40 to 65 percent Svea soil and 25 to 45 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth

of about 60 inches is light olive brown, mottled, calcareous loam. In some places the subsoil contains more clay. In other places the soil contains more sand and less clay. In some areas the surface layer and the upper part of the subsoil contain more silt and clay and less sand.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 29 inches thick. It is very dark brown in the upper part, dark brown in the next part, and olive brown and calcareous in the lower part. The next layer is dark grayish brown, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches also is dark grayish brown, calcareous loam. In some places the subsoil contains more clay. In other places the surface layer and the upper part of the subsoil contain more silt and clay and less sand.

Included with these soils in mapping are small areas of Cresbard, Hamerly, Tonka, and Wyard soils. Also included are small areas of well drained soils that have a substratum of sand and gravel at a depth of 20 to 40 inches. Included soils make up about 5 to 20 percent of the unit. Cresbard soils have a dense, sodic subsoil. They are intermingled with areas of the Svea soil. The somewhat poorly drained Hamerly soils are on flats. The poorly drained Tonka soils are in depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderately slow in the Svea and Barnes soils. Runoff is slow. Water runs onto the Svea soil from the higher adjacent areas. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is maintaining tilth and fertility. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control local erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and fertility and increase the rate of water infiltration.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of these soils for pasture.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIc. The productivity index of the unit for spring wheat is 91. The pasture group of the Svea soil is Overflow and Run-on, and that of the Barnes soil is Loamy and Silty.

1765—Svea-Buse loams, 3 to 6 percent slopes. These very deep, undulating soils are on rises on till plains. The moderately well drained Svea soil is on foot slopes. The well drained Buse soil is on summits (fig. 11). Individual areas range from about 5 to 1,500 acres in size. They are about 35 to 60 percent Svea soil and 25 to 50 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the soil contains more sand and less clay. In other places the dark color of the surface layer extends to a depth of less than 16 inches. In some areas the soil is well drained. In other areas the subsoil contains more clay.

Typically, the Buse soil has a surface layer of very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part. In some places the surface layer is dark grayish brown and is eroded. In other places the soil contains less clay and more sand.

Included with these soils in mapping are small areas of Brantford, Hamerly, Parnell, Swenoda, Tonka, and Wyard soils. Also included are some gently rolling areas. Included soils make up about 5 to 25 percent of the unit. Brantford soils have a substratum of sand and gravel. They are on knolls. The somewhat poorly drained Hamerly soils are on flats. The very poorly drained Parnell soils are in deep depressions. Swenoda soils are fine sandy loam in the surface layer and in the upper part of the subsoil. They are intermingled with areas of the Svea soil. The poorly drained Tonka soils are in depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderately slow in the Svea and Buse soils. Runoff is medium. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil.

Figure 11.—An area of Svea-Buse loams, 3 to 6 percent slopes. The Buse soil is in the light colored areas, and the Svea soil is in the dark areas. Southam silty clay loam is in the background.

Available water capacity is high in both soils. Organic matter content is high in the Svea soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazard of soil blowing is slight on the Svea soil and moderate on the Buse soil. The hazard of water erosion is moderate on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, buffer strips, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing on the Buse soil and water erosion on both soils are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an

annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Svea soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 70. The pasture group of the Svea soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

1766—Svea-Buse loams, 6 to 9 percent slopes. These very deep, gently rolling soils are on rises, knolls, and ridges on till plains. The moderately well drained Svea soil is on foot slopes. The well drained Buse soil is on shoulder slopes and summits. Individual areas range from about 5 to 1,500 acres in size. They are about 30 to 55 percent Svea soil and 30 to 55 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the soil contains more sand and less clay. In other places the dark color of the surface layer extends to a depth of less than 16 inches. In some areas the soil is well drained.

Typically, the Buse soil has a surface layer of very dark gray, calcareous loam about 6 inches thick. The subsoil is calcareous loam about 30 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is calcareous loam. It is olive brown in the upper part and light olive brown in the lower part. In some places the surface layer is dark grayish brown and is eroded. In other places the soil contains less clay and more sand. In some areas it contains less clay and more silt.

Included with these soils in mapping are small areas of Brantford, Hamerly, Parnell, Tonka, and Wyard soils. Also included are some rolling areas and some areas of well drained soils that have a sandy subsoil. Included soils make up about 5 to 20 percent of the unit. Brantford soils have a substratum of sand and gravel. They are on knolls. The somewhat poorly drained Hamerly soils are on flats. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in shallow depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderately slow in the Svea and Buse soils. Runoff is rapid. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Available water capacity is high in both soils. Organic matter content is high in the Svea soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are poorly suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazard of soil blowing is slight on the Svea soil and moderate on the Buse soil. The hazard of water erosion is severe on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, cover crops, buffer strips, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration.

Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing on the Buse soil and water erosion on both soils are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Svea soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Svea soil is IIIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 54. The pasture group of the Svea soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

1769—Svea-Cresbard loams, 0 to 3 percent slopes. These very deep, level and nearly level, moderately well drained soils are on till plains. The Svea soil is on rises. The sodic Cresbard soil is on flats. Individual areas range from about 3 to 700 acres in size. They are about 30 to 55 percent Svea soil and 30 to 55 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and pale brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the dark color of the surface layer extends to a depth of less than 16 inches. In other places the surface layer and the upper part of the subsoil contain more silt and clay and less sand.

Typically, the Cresbard soil has a surface layer of black loam about 8 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The next layer is black and very dark gray clay loam about 2 inches thick. Below this is a sodic subsoil, which is about 35 inches thick. The subsoil generally is dense but is not dense in the upper part. In sequence downward, it is very dark grayish brown clay loam; dark grayish brown clay loam; light olive brown, calcareous clay loam; and light olive brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In places the upper part of the subsoil is dense.

Included with these soils in mapping are small areas of Buse soils; the nonsaline and saline Hamerly soils; and Miranda, Tonka, and Wyard soils. These included soils make up about 5 to 25 percent of the unit. The well drained Buse soils are on knolls. The somewhat poorly drained Hamerly and Miranda soils are intermingled with areas of the Cresbard soil. The poorly drained Tonka soils are in depressions. The somewhat poorly drained Wyard soils are in swales.

Permeability is moderately slow in the Svea soil and slow in the Cresbard soil. Runoff is slow on both soils. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Available water capacity and organic matter content are high. Tilth is good in the Svea soil and fair in the Cresbard soil. The dense, sodic subsoil in the Cresbard soil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. A few are used for pasture or hay. These soils are suited to small grain, sunflowers, and alfalfa. The main concerns in managing cultivated areas are maintaining or improving tilth and improving root penetration in the dense, sodic subsoil of the Cresbard soil. Crops growing on the Cresbard soil typically appear stunted because of moisture stress. The hazards of soil blowing and water erosion are slight. Keeping crop residue on the surface and adding organic material to the plow layer help improve tilth and fertility and increase the rate of water infiltration. Growing deep-rooted legumes, such as alfalfa, improves root penetration in the dense, sodic subsoil of the Cresbard soil. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Smooth bromegrass, western wheatgrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of these soils for pasture.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Cresbard soil is suited to many of the climatically adapted species. Individual trees and shrubs on the Cresbard soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, sodic subsoil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Svea soil is IIc, and that of the Cresbard soil is IIIs. The productivity index of the unit for spring wheat is 81. The pasture group of the Svea soil is Overflow and Run-On, and that of the Cresbard soil is Clayey Subsoil.

1780—Swenoda fine sandy loam. This very deep, level, moderately well drained soil is on flats on delta plains and till plains. Individual areas range from about 5 to 450 acres in size.

Typically, the surface soil is fine sandy loam about 15 inches thick. It is black in the upper part and very dark gray in the lower part. The upper part of the subsoil is fine sandy loam about 15 inches thick. It is very dark grayish brown between depths of 15 and 26 inches and olive brown and mottled between depths of 26 and 30 inches. The lower part of the subsoil to a depth of about 60 inches is mottled. In sequence downward, it is dark grayish brown loam; light brownish gray, calcareous silt loam; and grayish brown, calcareous silty clay loam. In some places the upper part of the subsoil is sandy. In other places the surface soil is loam. In some areas depth to the lower part of the subsoil is 40 to 60 inches. In other areas the soil is well drained and is dark to a depth of less than 16 inches.

Included with this soil in mapping are small areas of Gardena, Kratka, Lankin, and Tiffany soils. Also included are a few small areas of moderately well drained soils that have a substratum of fine sand at a depth of about 25 to 60 inches. Included soils make up about 1 to 10 percent of the unit. Gardena and Lankin soils are intermingled with areas of the Swenoda soil. Gardena soils have a higher content of silt and very fine sand and a lower content of fine sand and coarser sand throughout than the Swenoda soil. Lankin soils contain more clay and less sand in the upper part than the

Swenoda soil. Kratka and Tiffany soils are poorly drained. Kratka soils are on the lower flats, and Tiffany soils are in depressions.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. Runoff is very slow. A seasonal high water table is at a depth of 2.5 to 4.0 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 77. The pasture group is Sandy.

1883—Vallers-Parnell complex. These very deep, level soils are on till plains. The poorly drained, highly calcareous Vallers soil is on flats. The very poorly drained Parnell soil is in depressions. It is subject to ponding. Individual areas range from about 3 to 100 acres in size. They are about 35 to 60 percent Vallers soil and 30 to 55 percent Parnell soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Vallers soil has a surface layer of black, calcareous loam about 9 inches thick. The next layer is very dark gray, calcareous loam about 4 inches thick. The subsoil is calcareous loam about 19 inches thick. It is dark gray in the upper part and olive gray in the lower part. It is mottled between depths of 26 and 32 inches. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some places the soil contains less sand and more silt. In other places it is somewhat poorly drained and has an olive brown substratum.

Typically, the Parnell soil has a surface soil of black silty clay loam about 12 inches thick. The subsoil is silty clay about 38 inches thick. It is very dark gray in the upper part, very dark gray and mottled in the next part, and dark olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay. In some places the surface soil contains less clay. In other places the soil has a leached subsurface layer. In some areas the soil contains less clay and more sand. In other places it contains less clay and more silt.

Included with these soils in mapping are small areas of Marysland and Southam soils and the saline Vallers soils. These included soils make up about 1 to 15 percent of the unit. Marysland soils and the saline Vallers soils are intermingled with areas of the Vallers soil. Marysland soils have a substratum of sand and gravel. The saline Vallers soils have accumulations of salts in the surface layer and subsoil. Southam soils have a seasonal high water table above or near the surface throughout the year. They are in the deeper depressions.

Permeability is moderately slow in the Vallers soil and slow in the Parnell soil. Runoff is very slow on the Vallers soil and ponded on the Parnell soil. A seasonal high water table is at a depth of 1.0 to 2.5 feet in the Vallers soil and is 2.0 feet above to 2.0 feet below the surface of the Parnell soil. Available water capacity and organic matter content are high in both soils. Tilth is good in the Vallers soil and fair in the Parnell soil.

Most areas are used for cultivated crops, hay, pasture, or wetland wildlife habitat. If drained, these soils are suited to small grain and sunflowers. Undrained areas, however, are poorly suited to these crops. Suitable drainage outlets are not readily available. As a result, only a few areas are drained. In undrained areas of the Parnell soil, tillage, seeding, and harvesting are frequently delayed or prevented by ponded surface water and crops are harvested in only about 1 to 3 years out of 10. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate on the Vallers soil and slight on the Parnell soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and stripcropping help to control soil

blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction and increases the rate of water infiltration.

The Parnell soil and the ponded water provide breeding sites and high-quality invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

Creeping foxtail, reed canarygrass, switchgrass, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the pasture is grazed when the Parnell soil is wet. They can be overcome by deferring grazing during wet periods. Soil blowing is a hazard on the Vallers soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

If drained, these soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on these soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Vallers soil is IIw, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat ranges from 32 to 70, depending on the degree of drainage. The pasture group of the Vallers soil and of drained areas of the Parnell soil is Wet.

1886—Vallers and Hamerly loams, saline, 0 to 3 percent slopes. These very deep, highly calcareous, moderately saline soils are on flats on till plains. The level Vallers soil is poorly drained. The level and nearly level Hamerly soil is somewhat poorly drained. Individual areas range from about 5 to 700 acres in size. Any one area can consist of all Vallers soil, all Hamerly soil, or a combination of both soils.

Typically, the Vallers soil has a surface layer of black, calcareous loam about 9 inches thick. The next layer is very dark gray, calcareous loam about 4 inches thick. The subsoil is calcareous loam about 19 inches thick. It is dark gray in the upper part and olive gray in the lower part. It is mottled between depths of 26 and 32 inches. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some places the soil contains less sand and more silt. In other places it has a substratum of sand and gravel at a depth of 20 to 40 inches. In some areas the soil is only slightly saline.

Typically, the Hamerly soil has a surface layer of black, calcareous loam about 9 inches thick. The subsoil is calcareous loam about 28 inches thick. It is light brownish gray in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some places the surface layer and the upper part of the subsoil contain less sand and more silt. In other places the soil contains less clay and more sand. In some areas it is only slightly saline.

Included with these soils in mapping are small areas of Miranda, Parnell, Tonka, and Wyard soils. Also included are some undulating areas. Included soils make up about 5 to 20 percent of the unit. Miranda soils have a dense, sodic subsoil. They are intermingled with areas of the Hamerly soil. The very poorly drained Parnell soils are in deep depressions. Tonka soils have a leached subsurface layer and have accumulated clay in the subsoil. They are in shallow depressions. Wyard soils do not have accumulated lime within a depth of 20 inches. They are in swales.

Permeability is moderately slow in the Vallers and Hamerly soils. Runoff is slow. A seasonal high water table is within a depth of 1 foot in the Vallers soil and at a depth of 2 to 4 feet in the Hamerly soil. Available water capacity is moderate in both soils. Salts reduce the amount of water available to plants. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. These soils are best suited to hay, pasture, and wildlife habitat. They are poorly suited to cultivated crops because of wetness and salinity. The main concerns in managing cultivated areas are overcoming salinity, reducing wetness, and controlling soil blowing. The hazard of soil blowing is moderate on both soils, and the hazard of water erosion is slight. In undrained areas of the Vallers soil, wetness delays or prevents tillage and seeding in some years. Fallowing should be avoided because it can result in an increased accumulation of salts in the surface layer. Growing salt-tolerant crops, such as barley, helps to overcome the salinity. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the

proper soil moisture content helps to prevent surface compaction.

Alkali sacaton, tall wheatgrass, western wheatgrass, and sweetclover are suitable hay and pasture plants. The hazard of soil blowing, the high content of salts, and the reduced amount of water available to plants are problems, especially if the pasture is overgrazed. Maintaining an adequate cover of salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of these soils frequently contain salty water.

These soils are suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water caused by the salts in the soils. Reducing the evaporation rate at the surface increases the seedling survival rate. If the surface is bare as the soils become dry, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index of the unit for spring wheat ranges from 24 to 52, depending on the degree of drainage in areas of the Vallers soil. The pasture group is Saline.

1978—Water. This map unit occurs as areas of water that are about 5 to more than 15 feet deep. Individual areas range from about 3 to more than 200 acres in size. The smaller areas generally are shallow ponds and streams, and the larger areas generally are shallow lakes. Most areas are irregularly shaped, circular, or oblong, but the streams generally are long and narrow.

Included in this unit in mapping are small areas of the poorly drained Colvin and very poorly drained Southam soils. These soils make up about 5 percent of the unit. They are on the perimeter of the mapped areas.

Most areas are used for wildlife habitat and recreation. This unit is best suited to these uses. Most areas are a good source of water for livestock. Areas where the water is brackish, however, are poorly suited to this use.

2121—Miranda loam, 0 to 3 percent slopes. This very deep, level and nearly level, somewhat poorly drained, sodic-saline soil is on flats on till plains. Individual areas range from about 10 to 350 acres in size.

Typically, the surface layer is black loam about 4 inches thick. The subsurface layer is very dark gray loam about 1 inch thick. The subsoil is about 37 inches thick. It is very dark grayish brown clay loam in the upper part; dark grayish brown, calcareous clay loam in the next part; and light olive brown, calcareous loam in the lower part. It is mottled at a depth of about 26 inches. The substratum to a depth of about 60 inches is olive brown, mottled, calcareous loam. In some places the surface layer has been mixed with the subsoil by cultivation. In other places the depth to salts is more than 16 inches. In some areas the soil is poorly drained.

Included with this soil in mapping are small areas of Barnes, Cresbard, Fram, Marysland, and Wyard soils. These soils make up about 5 to 25 percent of the unit. The well drained Barnes and moderately well drained Cresbard soils are on rises. The highly calcareous Fram soils are intermingled with areas of the Miranda soil. The poorly drained Marysland soils are on the lower flats. Wyard soils have a mottled subsoil and do not have salts or lime within a depth of 20 inches. They are in swales.

Permeability is very slow in the Miranda soil. Runoff is slow. A seasonal high water table is at a depth of 2 to 4 feet. Available water capacity is moderate. Salts reduce the amount of water available to plants. Organic matter content is moderately low. The dense, sodic subsoil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is best suited to pasture and hay. It is generally unsuited to cultivated crops and trees and shrubs because of the dense, sodic subsoil and the salinity. Western wheatgrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. The dense, sodic subsoil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to prevent denuding. Stock water ponds constructed in areas of this soil frequently contain salty water.

The land capability classification is VIs. The productivity index for spring wheat is 0. The pasture group is Thin Claypan.

2151—Binford-Coe sandy loams, 0 to 6 percent slopes. These very deep, level to undulating soils are on flats and rises on outwash plains and terraces. The Binford soil is somewhat excessively drained. The Coe soil is excessively drained. Individual areas range from about 3 to 300 acres in size. They are about 40 to 65 percent Binford soil and 30 to 55 percent Coe soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Binford soil has a surface layer of black sandy loam about 9 inches thick. The subsoil is dark

grayish brown sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous. It is very dark grayish brown very gravelly coarse sand in the upper part, brown gravelly coarse sand in the next part, and dark grayish brown gravelly coarse sand in the lower part. In some places the surface layer and the upper part of the subsoil contain more clay and less sand. In other places less than 20 percent of the gravel in the substratum is shale. In some areas depth to the substratum of sand and gravel is 20 to 30 inches. In a few areas the substratum is fine sand and has less than 5 percent gravel. In other areas the surface layer is gravelly sandy loam.

Typically, the Coe soil has a surface layer of very dark gray, calcareous sandy loam about 8 inches thick. The subsoil is dark grayish brown, calcareous very gravelly coarse sand about 9 inches thick. The substratum to a depth of about 60 inches is calcareous. It is dark grayish brown very gravelly coarse sand in the upper part, grayish brown gravelly sand in the next part, and dark grayish brown very gravelly coarse sand in the lower part. In some places the surface layer is gravelly sandy loam. In other places less than 20 percent of the gravel in the subsoil and substratum is shale. In some areas the subsoil and substratum have 15 to 35 percent gravel.

Included with these soils in mapping are small areas of Divide, Esmond, and Heimdal soils. Also included, in swales, are small areas of well drained soils that have a surface layer and subsoil of loam and have a substratum of sand and gravel at a depth of more than 20 inches. Included soils make up about 1 to 10 percent of the unit. The somewhat poorly drained Divide soils are on the lower flats. The well drained Esmond soils are intermingled with areas of the Coe soil. The well drained Heimdal soils are intermingled with areas of the Binford soil.

Permeability is moderately rapid in the Binford soil. It is moderate in the upper part of the Coe soil and very rapid in the lower part. Runoff is very slow on both soils. Available water capacity is low in the Binford soil and very low in the Coe soil. Organic matter content is moderate in both soils. Tilth is good.

Most areas are used for cultivated crops. Some are used for pasture or hay. These soils are best suited to pasture and hay. They are very poorly suited to spring wheat, corn, soybeans, and sunflowers. Rye and winter wheat make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the early season moisture supply. Because of the low or very low available water capacity of these soils, fallowing is of limited value. It increases the susceptibility to soil blowing. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Crested wheatgrass, western wheatgrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

The Binford soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. The Coe soil is generally unsuited to windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Binford soil is IIIe, and that of the Coe soil is VIs. The productivity index of the unit for spring wheat is 31. The pasture group of the Binford soil is Shallow to Gravel, and that of the Coe soil is Very Shallow to Gravel.

2152—Coe-Binford complex, 6 to 25 percent slopes. These very deep soils are on knolls and ridges on outwash plains and terraces. The excessively drained, gently rolling to hilly Coe soil is on shoulder slopes and summits. The somewhat excessively drained, gently rolling and rolling Binford soil is on side slopes. Individual areas range from about 3 to 200 acres in size. They are about 40 to 65 percent Coe soil

and 15 to 40 percent Binford soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Coe soil has a surface layer of very dark gray, calcareous gravelly sandy loam about 8 inches thick. The subsoil is dark grayish brown, calcareous very gravelly coarse sand about 9 inches thick. The substratum to a depth of about 60 inches is calcareous. It is dark grayish brown very gravelly coarse sand in the upper part, grayish brown gravelly sand in the next part, and dark grayish brown very gravelly coarse sand in the lower part. In some places less than 20 percent of the gravel in the subsoil and substratum is shale. In other places the subsoil and substratum have 15 to 35 percent gravel. In some areas the soil has a substratum of loam below a depth of 40 inches. In other areas the surface layer is sandy loam.

Typically, the Binford soil has a surface layer of black sandy loam about 9 inches thick. The subsoil is dark grayish brown sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous. It is very dark grayish brown very gravelly coarse sand in the upper part, brown gravelly coarse sand in the next part, and dark grayish brown gravelly coarse sand in the lower part. In some places depth to the substratum of sand and gravel is 20 to 30 inches. In other places the substratum has more than 35 percent gravel. In some areas the surface layer and the upper part of the subsoil contain more clay and less sand. In other areas less than 20 percent of the gravel in the substratum is shale. In a few places the soil has a substratum of loam below a depth of 40 inches. In a few areas the soil is sandy throughout and has less than 5 percent gravel.

Included with these soils in mapping are small areas of Esmond, Fram, and Heimdal soils. Also included, in swales, are small areas of well drained soils that have a surface layer and subsoil of loam and have a substratum of sand and gravel at a depth of more than 20 inches. Included soils make up about 10 to 30 percent of the unit. The well drained Esmond soils are intermingled with areas of the Coe soil. The somewhat poorly drained Fram soils are on flats. The well drained Heimdal soils are intermingled with areas of the Binford soil.

Permeability is moderately rapid in the upper part of the Coe soil and very rapid in the lower part. It is moderately rapid in the Binford soil. Runoff is medium on the Coe soil and slow on the Binford soil. Available water capacity is very low in the Coe soil and low in the Binford soil. Organic matter content is moderate in both soils.

Most areas are used for cultivated crops. Some are used for pasture, hay, or range. These soils are best suited to pasture, hay, and range. They are generally unsuited to cultivated crops because of droughtiness in both soils and a severe hazard of soil blowing on the Binford soil. Returning cultivated areas to a cover of grasses and legumes helps to control erosion.

In areas where these soils are used for range, the important forage plants are needleandthread, blue grama, and western wheatgrass. Crested wheatgrass, western wheatgrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as scalp or hand planting, is applied.

The land capability classification of the Coe soil is VIIs, and that of the Binford soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Coe soil is Very Shallow, and that of the Binford soil is Shallow to Gravel. The pasture group of the Coe soil is Very Shallow to Gravel, and that of the Binford soil is Shallow to Gravel.

2153—Edgeley-Kloten-Esmond complex, 9 to 35 percent slopes. These rolling to steep, well drained soils are on ridges in valleys. The moderately deep Edgeley soil is on side slopes. The shallow Kloten soil is on shoulder slopes. The very deep Esmond soil is on summits. The soils are subject to slumping and soil creep. Individual areas range from about 15 to 800 acres in size. They are about 45 to 70 percent Edgeley soil, 15 to 35 percent Kloten soil, and 5 to 20 percent Esmond soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Edgeley soil has a surface layer of black silt loam about 8 inches thick. The subsoil is about 28 inches thick. It is dark brown loam in the upper part and dark grayish brown, calcareous silty clay loam in the lower part. Below this is dark olive gray, weathered shale bedrock. In some places the weathered shale bedrock is below a depth of 40 inches. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Kloten soil has a surface layer of very dark gray, calcareous silt loam about 7 inches thick. Below this is dark olive gray, weathered shale bedrock. In places the surface layer is silty clay loam or loam.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 19 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In places the soil contains more clay and less sand.

Included with these soils in mapping are small areas of Coe, Emrick, LaDelle, and Lamoure soils and small areas of somewhat poorly drained soils that have a dense, sodic subsoil. Also included, on foot slopes, are some areas of well drained soils that are silty clay throughout. Included soils make up about 5 to 20 percent of the unit. The excessively drained Coe soils are intermingled with areas of the Esmond soil. Emrick soils are dark to a depth of more than 16 inches. They are on foot slopes. The moderately well drained LaDelle soils are on flood plains. The poorly drained Lamoure soils are in drainageways.

Permeability is moderate in the Edgeley, Kloten, and Esmond soils. Runoff is very rapid. Available water capacity is moderate in the Edgeley soil, very low in the Kloten soil, and high in the Esmond soil. Organic matter content is high in the Edgeley and Kloten soils and moderately low in the Esmond soil. The weathered shale bedrock underlying the Edgeley and Kloten soils restricts the depth to which roots can penetrate.

Most areas are used for pasture, range, or wildlife habitat. These soils are best suited to range and wildlife habitat. They are generally unsuited to cultivated crops and pasture because of a very severe hazard of water erosion and the slope. The important range plants on these soils are western wheatgrass, needleandthread, little bluestem, and blue grama. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important plants at a height that traps snow can increase the moisture supply and control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

The land capability classification of the Edgeley soil is VIe, and that of the Kloten and Esmond soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Edgeley soil is Silty, that of the Kloten soil is Shallow, and that of the Esmond soil is Thin Upland.

2154—Glyndon-Tiffany loams. These very deep, level, somewhat poorly drained soils are on lake plains. The highly calcareous Glyndon soil is on flats. The Tiffany soil is in swales. Individual areas range from about 15 to 3,000 acres in size. They are about 55 to 75 percent Glyndon soil and 15 to 35 percent Tiffany soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Glyndon soil has a surface layer of black, calcareous loam about 7 inches thick. The subsoil is about 23 inches thick. It is calcareous. It is grayish brown loam in the upper part and light olive brown silt loam in the lower part. The substratum to a depth of about 60 inches is mottled, calcareous silt loam. It is light olive brown in the upper part and light yellowish brown in the lower part. In some places the soil contains more clay and less silt. In other places it contains more sand and less silt. In some areas the surface layer is loam or very fine sandy loam.

Typically, the surface soil of the Tiffany soil is about 22 inches thick. It is black loam in the upper part and very dark gray, mottled fine sandy loam in the lower part. The substratum to a depth of about 60 inches is olive gray and mottled. In sequence downward, it is fine sandy loam, loamy fine sand, fine sandy loam, silty clay loam, and silt loam. In some places the dark color of the surface soil and the upper part of the subsoil extends to a depth of more than 24 inches. In other places the soil contains less clay and more silt. In some areas the surface soil is silt loam.

Included with these soils in mapping are small areas of Perella soils and small areas of poorly drained soils in depressions. The poorly drained soils have accumulated clay in the subsoil. Also included are a few small areas of poorly drained, highly calcareous soils. Included soils make up about 5 to 15 percent of the unit. Perella soils contain more silt and clay in the upper part than the Tiffany soil. They are intermingled with areas of the Tiffany soil.

Permeability is moderate in the Glyndon soil. It is moderately rapid in the upper part of the Tiffany soil and moderately slow in the lower part. Runoff is very slow on both soils. A seasonal high water table is at a depth of 2.5 to 6.0 feet in the Glyndon soil and at a depth of 1.0 to 3.0 feet in the Tiffany soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage

and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate on the Glyndon soil and slight on the Tiffany soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

Switchgrass, big bluestem, slender wheatgrass, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard on the Glyndon soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Glyndon soil is IIe, and that of the Tiffany soil is IIw. The productivity index of the unit for spring wheat is 92. The pasture group of the Glyndon soil is Limy Subirrigated, and that of the Tiffany soil is Wet.

2155—Hecla loamy fine sand. This very deep, level, moderately well drained soil is on flats on delta plains. Individual areas range from about 5 to 500 acres in size.

Typically, the surface soil is loamy fine sand about 24 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is very dark grayish brown fine sand about 7 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is light olive brown in the upper part and olive brown in the lower part. In some places the upper part of the surface soil is fine sandy loam. In other places the substratum is gravelly sand below a depth of 40 inches. In some areas the substratum contains less sand and more clay and silt below a depth of 40 inches.

Included with this soil in mapping are small areas of the somewhat excessively drained Binford and well drained Maddock soils on rises. Also included, in swales, are a few small areas of somewhat poorly drained soils that are mottled in the lower part of the surface soil. Included soils make up about 5 to 20 percent of the unit.

Permeability is rapid in the Hecla soil. Runoff is very slow. A seasonal high water table is at a depth of 3 to 6 feet. Available water capacity is low. Organic matter content is moderately low. Tilth is fair.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is poorly suited to small grain and soybeans. Rye and winter wheat make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring, but the soil is better suited to the deeper rooted crops or forage plants, such as corn, sunflowers, and alfalfa, which generally can make better use of the seasonal high water table. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the early season moisture supply. Because of the low available water capacity, fallowing is of limited value. It increases the susceptibility to soil blowing. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain or improve tilth.

Switchgrass, prairie sandreed, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IVe. The productivity index for spring wheat is 53. The pasture group is Sands.

2156—Lamoure and Rauville silt loams. These very deep, level, calcareous soils are in drainageways on till plains. They are frequently flooded. The Lamoure soil is poorly drained, and the Rauville soil is very poorly drained. Individual areas range from about 5 to 500 acres in size. Any one area can consist of all Lamoure soil, all Rauville soil, or a combination of both soils.

Typically, the Lamoure soil has a surface soil of black, calcareous silt loam about 30 inches thick. The substratum to a depth of about 60 inches is mottled, calcareous silt loam. It is dark gray in the upper part and olive gray in the lower part. In some places the soil has accumulated lime within a depth of 16 inches. In other places it contains more sand and less silt.

Typically, the Rauville soil has a calcareous surface soil about 29 inches thick. The surface soil is black muck in the upper part, black silt loam in the next part, and very dark gray silt loam in the lower part. The substratum to a depth of about 60 inches is calcareous. It is dark gray silty clay loam in the upper part and gray clay loam in the lower part. In some places the upper part of the surface soil is muck 8 to 16 inches thick. In other places the soil contains more sand and less clay.

Included with these soils in mapping are small areas of Divide and Marysland soils. Also included are small areas of moderately well drained soils on rises. Included soils make up about 1 to 15 percent of the unit. Divide and Marysland soils are intermingled with areas of the Lamoure soil. Divide soils are somewhat poorly drained. Marysland soils have a substratum of sand and gravel.

Permeability is moderate in the Lamoure and Rauville soils. Runoff is very slow. A seasonal high water table is within a depth of 2 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for pasture, hay, or wetland wildlife habitat. A few areas of the Lamoure soil are used for cultivated crops. The Lamoure soil is best suited to pasture and hay. The Rauville soil is best suited to wetland wildlife habitat. If drained and protected from flooding, the Lamoure soil is suited to small grain and sunflowers. Undrained and unprotected areas, however, are generally unsuited to crops because of wetness and flooding. Stream channelization generally is difficult, and suitable drainage outlets are not readily available. As a result, very few areas are drained. If the Lamoure soil is drained and protected from flooding, the main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Tillage at the proper soil moisture content helps to prevent surface compaction.

Creeping foxtail, reed canarygrass, switchgrass, and alsike clover are suitable hay and pasture plants on the Lamoure soil. The Rauville soil is not suited to pasture or hay because of wetness and flooding. Compaction, trampling, and root shearing are problems, especially if the pasture is grazed during wet periods. They can be overcome by deferring grazing when the soils are wet. Soil blowing is a hazard on the Lamoure soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

If drained, the Lamoure soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion. The Rauville soil is generally unsuited to windbreaks and environmental plantings.

The land capability classification of the Lamoure soil is IIw, and that of the Rauville soil is IIIw. The productivity index of the unit for spring wheat ranges from 0 to 70, depending on the degree of drainage. The pasture group of the Lamoure soil and of drained areas of the Rauville soil is Wet.

2157—Maddock-Esmond-Embden complex, 6 to 15 percent slopes. These very deep, well drained soils are on kames on till plains. The gently rolling and rolling Maddock soil is on side slopes and summits. The gently rolling and rolling Esmond soil is on shoulder slopes and summits. The gently rolling Embden soil is on foot slopes. Individual areas range from about 5 to 100 acres in size. They are about 45 to 70 percent Maddock soil, 15 to 40 percent Esmond soil, and 5 to 20 percent Embden soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Maddock soil has a surface soil of very dark gray loamy fine sand about 11 inches thick. The subsoil is dark brown fine sand about 18 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous fine sand. In some places the surface layer is fine sandy loam. In other places the surface layer is less than 10 inches thick and is eroded. In some areas the subsoil and substratum contain more

clay and less sand between depths of 20 and 60 inches. In other areas, the soil is moderately well drained and the dark color of the surface soil extends to a depth of more than 16 inches. In a few areas the soil has a higher content of coarse sand.

Typically, the Esmond soil has a surface layer of very dark gray, calcareous loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 19 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some places the soil is sandy in the lower part. In other places the surface layer and the upper part of the subsoil are not calcareous. In some areas the soil contains more silt and less sand. In other areas it contains less sand and more clay.

Typically, the Embden soil has a surface soil of black fine sandy loam about 10 inches thick. The subsoil is fine sandy loam about 26 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The upper part of the substratum is olive brown fine sandy loam. The lower part to a depth of about 60 inches is dark grayish brown, calcareous loamy fine sand. In some places the dark color of the surface layer and subsoil extends to a depth of less than 16 inches. In other places the soil contains more clay and less sand throughout. In some areas the lower part of the subsoil and the substratum have more clay and less sand.

Included with these soils in mapping are small areas of Binford, Coe, and Wyndmere soils. These included soils make up about 1 to 10 percent of the unit. The somewhat excessively drained Binford soils are intermingled with areas of the Maddock soil. The excessively drained Coe soils are intermingled with areas of the Esmond soil. The somewhat poorly drained, highly calcareous Wyndmere soils are on low flats.

Permeability is rapid in the Maddock soil, moderate in the Esmond soil, and moderately rapid in the Embden soil. Runoff is slow on the Maddock soil, rapid on the Esmond soil, and medium on the Embden soil. Available water capacity is low in the Maddock soil, high in the Esmond soil, and moderate in the Embden soil. Organic matter content is moderately low in the Maddock and Esmond soils and high in the Embden soil.

Most areas are used for cultivated crops, pasture, or hay. These soils are best suited to pasture and hay. They are generally unsuited to cultivated crops because of a severe hazard of water erosion, droughtiness, and the slope. Returning cultivated areas to a cover of grasses and legumes helps to control erosion.

Switchgrass, prairie sandreed, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing, water erosion, and drought are hazards, especially if the pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants at a height that traps snow can increase the moisture supply, control soil blowing and water erosion, and prevent denuding. Denuding can occur along cattle trails and in areas where cattle congregate. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding and gullying.

The Maddock and Esmond soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Embden soil is suited to many of the climatically adapted species. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Maddock and Esmond soils is VIe, and that of the Embden soil is IVe. The productivity index of the unit for spring wheat is 0. The pasture group of the Maddock soil is Sands, that of the Esmond soil is Thin Upland, and that of the Embden soil is Sandy.

2158—Velva fine sandy loam, 0 to 6 percent slopes. This very deep, level to undulating, well drained soil is on flats and rises on flood plains and terraces. It is occasionally flooded. Individual areas range from about 5 to 500 acres in size.

Typically, the surface layer is black, calcareous fine sandy loam about 6 inches thick. The next layer is very dark grayish brown, calcareous fine sandy loam about 6 inches thick. The upper 13 inches of the substratum is dark grayish brown, calcareous loamy fine sand and very dark grayish brown, calcareous fine sandy loam. The next 5 inches is black fine sandy loam. The lower part to a depth of about 60 inches is very dark grayish brown fine sandy loam. In some places the surface layer is loam. In other places the dark color of the surface layer extends to a depth of more than 16

inches. In some areas the soil is moderately well drained.

Included with this soil in mapping are small areas of the poorly drained Lamoure soils in oxbows and small areas of excessively drained soils on natural levees. The excessively drained soils contain more sand and less clay than the Velva soil. Also included are some areas of gently rolling, moderately well drained soils that contain more clay than the Velva soil. Included soils make up about 5 to 25 percent of the unit.

Permeability is moderately rapid in the Velva soil. Runoff is slow. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for pasture or hay. Some are used for cultivated crops. This soil is suited to small grain, corn, sunflowers, and soybeans. Flooding delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The main concern in managing cultivated crops is controlling soil blowing. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth.

Big bluestem, smooth bromegrass, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and scouring during periods of flooding are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and scouring. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIe. The productivity index for spring wheat is 67. The pasture group is Overflow and Run-on.

2159—Walsh silty clay loam, 1 to 6 percent slopes. This very deep, nearly level and gently sloping, well drained soil is on foot slopes in valleys. Individual areas range from about 10 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is silty clay loam about 30 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam. In places the dark color of the surface layer extends to a depth of less than 16 inches. In a few areas the soil has weathered shale bedrock at a depth of 20 to 40 inches.

Included in mapping are small areas of soils that contain more clay and less sand than the Walsh soil. These soils make up about 5 to 20 percent of the unit. They are intermingled with areas of the Walsh soil.

Permeability is moderately slow in the Walsh soil. Runoff is medium. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops. This soil is well suited to small grain, corn, and sunflowers. The main concerns in managing cultivated areas are controlling water erosion and maintaining or improving tilth. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain or improve tilth.

Smooth bromegrass, intermediate wheatgrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control water erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification is IIe. The productivity index for spring wheat is 86. The pasture group is Loamy and Silty.

2160—Wyndmere-Tiffany complex, silty substratum. These very deep, level soils are on delta plains and lake plains. The somewhat poorly drained, highly calcareous Wyndmere soil is on flats. The poorly drained Tiffany soil is in depressions. It is subject to ponding. Individual areas range from about 5 to 1,000 acres in size. They are about 45 to 70 percent

Wyndmere soil and 20 to 45 percent Tiffany soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Wyndmere soil has a surface layer of black, calcareous fine sandy loam about 8 inches thick. The subsoil is calcareous fine sandy loam about 21 inches thick. It is gray in the upper part, brown in the next part, and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is mottled and calcareous. In sequence downward, it is light yellowish brown loamy fine sand, light olive brown fine sandy loam, olive gray silty clay loam, and light yellowish brown silty clay loam. In some places the surface layer is loam. In other places the subsoil and substratum contain more sand and less clay between depths of 20 and 40 inches. In some areas depth to the silty part of the substratum 20 to 40 inches. In a few areas it is more than 60 inches.

Typically, the surface soil of the Tiffany soil is about 22 inches thick. It is black loam in the upper part and very dark gray, mottled fine sandy loam in the lower part. The substratum to a depth of about 60 inches is olive gray and mottled. In sequence downward, it is fine sandy loam, loamy fine sand, fine sandy loam, silty clay loam, and silt loam. In some places the upper part of the surface soil is fine sandy loam. In other places the soil has accumulated lime within a depth of 16 inches. In some areas depth to the silty part of the substratum is 20 to 40 inches. In other areas it is more than 65 inches. In a few areas the soil is somewhat poorly drained.

Included with these soils in mapping are small areas of Bearden, Embden, Kratka, and Swenoda soils. These included soils make up about 1 to 15 percent of the unit. Bearden soils contain more clay and silt than the Wyndmere soil. They are intermingled with areas of the Wyndmere soil. The moderately well drained Embden and Swenoda soils are on rises. Kratka soils contain more sand and less clay in the upper part than the Tiffany soil. They are intermingled with areas of the Tiffany soil.

Permeability is moderately rapid in the upper part of the Wyndmere and Tiffany soils and moderately slow in the lower part. Runoff is very slow on the Wyndmere soil and ponded on the Tiffany soil. A seasonal high water table is at a depth of 2 to 5 feet in the Wyndmere soil and is 1 foot above to 3 feet below the surface of the Tiffany soil. Available water capacity and organic matter content are high in both soils. Tilth is good.

Most areas are used for cultivated crops. Some are used for hay or pasture. These soils are suited to small grain, corn, soybeans, and sunflowers. The main concerns in managing cultivated areas are controlling soil blowing on the Wyndmere soil and reducing wetness in the Tiffany soil. Suitable drainage outlets are not readily available. As a result, few areas of the Tiffany soil are drained. In undrained areas of the Tiffany soil, ponding delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe on the Wyndmere soil. It is slight on the Tiffany soil, but soil blowing occurs during some windstorms. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth. Tillage at the proper soil moisture content helps to prevent surface compaction.

The Tiffany soil and the ponded water provide breeding sites and high-quality invertebrate protein for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

Switchgrass, big bluestem, sweetclover, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard on the Wyndmere soil, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

The Wyndmere soil and drained areas of the Tiffany soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tiffany soil, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tiffany soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Wyndmere soil is IIIe, and that of the Tiffany soil is IIw. The productivity index of the unit for spring wheat ranges from 57 to 70, depending on the degree of drainage. The pasture group of the Wyndmere soil is Limy Subirrigated, and that of the Tiffany soil is Wet.

2161—Zell-Overly silt loams, 6 to 9 percent slopes. These very deep, moderately sloping, well drained soils are on knolls and ridges on lake plains. The Zell soil is on shoulder slopes and summits. The Overly soil is on side slopes. Individual areas range from about 5 to 150

acres in size. They are about 35 to 60 percent Zell soil and 35 to 60 percent Overly soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zell soil has a surface layer of very dark grayish brown, calcareous silt loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and light brownish gray silt loam in the upper part, light yellowish brown and light brownish gray silt loam and very fine sandy loam in the next part, and light olive brown silt loam in the lower part. In some places the soil contains more clay and less silt. In other places it contains more sand and less silt.

Typically, the Overly soil has a surface soil of silt loam about 14 inches thick. The surface soil is black in the upper part and very dark gray in the lower part. The subsoil is silty clay loam about 17 inches thick. It is very dark grayish brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and grayish brown silty clay loam in the upper part; light yellowish brown, mottled silt loam in the next part; and grayish brown and light olive brown, mottled silty clay loam in the lower part. In some places the dark color of the surface soil extends to a depth of less than 16 inches. In other places the soil contains more silt and less clay. In some areas the upper part of the surface soil is very dark grayish brown and slightly calcareous because of erosional deposition from the higher adjacent areas.

Included with these soils in mapping are small areas of Coe, Embden, and Lamoure soils. Also included are some strongly sloping areas. Included soils make up about 1 to 10 percent of the unit. The excessively drained Coe soils are intermingled with areas of the Zell soil. Embden soils contain more sand and less clay than the Overly soil. They are intermingled with areas of the Overly soil. The poorly drained Lamoure soils are in drainageways.

Permeability is moderate in the Zell soil and moderately slow in the Overly soil. Runoff is rapid on both soils. Available water capacity is high. Organic matter content is moderate in the Zell soil and high in the Overly soil. Tilth is good in both soils.

Most areas are used for cultivated crops. Some are used for grazeable woodland or for pasture or hay. These soils are poorly suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazard of soil blowing is moderate on the Zell soil and slight on the Overly soil. The hazard of water erosion is severe on both soils (fig. 12). A system of conservation tillage that leaves crop residue on the surface, field windbreaks, cover crops, buffer strips, and grassed waterways in areas where runoff concentrates help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain tilth and increase the rate of water infiltration in the Overly soil.

Smooth bromegrass, green needlegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing on the Zell soil and water erosion on both soils are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Zell soil is suited to only the most drought-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely on this soil. The Overly soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification of the Zell soil is IVe, and that of the Overly soil is IIIe. The productivity index of the unit for spring wheat is 48. The pasture group of the Zell soil is Thin Upland, and that of the Overly soil is Loamy and Silty.

2162—Zell-Overly silt loams, 9 to 25 percent slopes. These very deep, well drained soils are on knolls and ridges on lake plains. The strongly sloping and moderately steep Zell soil is on shoulder slopes and summits. The strongly sloping Overly soil is on side slopes. Individual areas range from about 5 to 200 acres in size. They are about 35 to 60 percent Zell soil and 30 to 55 percent Overly soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zell soil has a surface layer of very dark grayish brown, calcareous silt loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and light brownish gray silt loam in the upper part, light yellowish brown and light brownish gray silt loam and very fine sandy loam in the next part, and light olive brown silt loam in the lower part. In places the soil contains more clay and

Figure 12.—A gully in an area Zell-Overly silt loams, 6 to 9 percent slopes. A grassed waterway is needed to control water erosion.

less silt. In a few areas it contains more sand and clay and less silt.

Typically, the Overly soil has a surface soil of silt loam about 14 inches thick. The surface soil is black in the upper part and very dark gray in the lower part. The subsoil is silty clay loam about 17 inches thick. It is very dark grayish brown in the upper part and light olive brown and calcareous in the lower part. The substratum to a depth of about 60 inches is calcareous. It is light olive brown and grayish brown silty clay loam in the upper part; light yellowish brown, mottled silt loam in the next part; and grayish brown and light olive brown, mottled silty clay loam in the lower part. In some places the dark color of the surface soil extends to a depth of less than 16 inches. In other places the soil contains more silt and less clay. In some areas the upper part of the surface soil is very dark grayish brown and slightly calcareous because of erosional deposition from the higher adjacent areas. In a few areas the soil contains more sand and less silt.

Included with these soils in mapping are small areas of Embden, Lamoure, and Maddock soils. Also included are some steep and very steep areas. Included soils make up about 1 to 15 percent of the unit. Embden soils contain more sand and less clay than the Overly soil. They are intermingled with areas of the Overly soil. The poorly drained Lamoure soils are in drainageways. Maddock soils are sandy throughout. They are intermingled with areas of the Zell soil.

Permeability is moderate in the Zell soil and moderately slow in the Overly soil. Runoff is very rapid on the Zell soil and rapid on the Overly soil. Available water capacity is high in both soils. Organic matter content is moderate in the Zell soil and high in the Overly soil.

Most areas are used for pasture. Some are used for

cultivated crops. These soils are best suited to pasture and hay. They are generally unsuited to cultivated crops because of soil blowing on the Zell soil, a very severe or severe hazard of water erosion on both soils, and the slope of both soils. Returning cultivated areas to a cover of grasses and legumes helps to control erosion. Smooth bromegrass, green needlegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion. Gullying can occur along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Zell soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. The Overly soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover increase the survival and growth rates of seedlings.

The land capability classification of the Zell soil is VIIe, and that of the Overly soil is IVe. The productivity index of the unit for spring wheat is 0. The pasture group of the Zell soil is Thin Upland, and that of the Overly soil is Loamy and Silty.

2163—Antler clay loam, saline. This very deep, level, somewhat poorly drained, highly calcareous, moderately saline soil is on flats on lake plains. Individual areas range from about 15 to 250 acres in size.

Typically, the surface layer is black, calcareous clay loam about 9 inches thick. The subsoil is about 35 inches thick. It is calcareous. It is dark gray clay loam in the upper part, grayish brown clay loam in the next part, and light olive brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some places the surface layer and the upper part of the subsoil are loam. In other places the soil contains more silt and less sand. In some areas it contains more sand and less clay. In other areas the soil is only slightly saline.

Included with this soil in mapping are small areas of the poorly drained, saline Colvin and Vallers soils and small areas of the poorly drained Tonka soils. These soils make up about 1 to 10 percent of the unit. The saline Colvin and Vallers soils are on the lower flats. Tonka soils are in depressions.

Permeability is moderately slow in the Antler soil. Runoff is very slow. A seasonal high water table is at a depth of 1 to 4 feet. Available water capacity is moderate. Salts reduce the amount of water available to plants. Organic matter content is high. Tilth is fair.

Most areas are used for cultivated crops. Some are used for pasture or hay. This soil is poorly suited to cultivated crops because of the salinity. The main concerns in managing cultivated areas are overcoming the salinity, controlling soil blowing, and maintaining or improving tilth. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Fallowing should be avoided because it can result in an increased accumulation of salts in the surface layer. Growing salt-tolerant crops, such as barley, helps to overcome the salinity. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Keeping crop residue on the surface and adding organic material to the plow layer help to maintain or improve tilth. Tillage at the proper soil moisture content helps to prevent surface compaction and improves tilth.

Alkali sacaton, tall wheatgrass, western wheatgrass, and sweetclover are suitable hay and pasture plants. The hazard of soil blowing, the high content of salts, and the reduced amount of water available to plants are problems, especially if the pasture is overgrazed. Maintaining an adequate cover of salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water caused by the salts in the soil. Reducing the evaporation rate at the surface increases the seedling survival rate. If the surface is bare as the soil becomes dry, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The land capability classification is IIIs. The productivity index for spring wheat is 49. The pasture group is Saline.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture.

It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 332,000 acres in the county, or more than 72 percent of the total acreage, meets the soil requirements for prime farmland. Extensive areas of this land are throughout the county, but most are in the central and eastern parts, mainly in associations 1, 4, 5, 6, 13, 14, and 15, which are described under the heading "General Soil Map Units." Most of the prime farmland is used for crops, mainly wheat and other small grain. The crops grown on this land account for a large share of the county's total agricultural income each year.

The map units in the survey area that are considered prime farmland are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

43	Antler clay loam
64	Arveson loam (where drained)
118	Barnes-Buse loams, 3 to 6 percent slopes
156	Barnes-Svea loams, 3 to 6 percent slopes
189	Bearden-Perella silty clay loams
450	Colvin silt loam (where drained)
511	Divide loam, 0 to 3 percent slopes
539	Edgeley loam, 0 to 3 percent slopes
569	Embden fine sandy loam
579	Embden-Egeland fine sandy loams, 1 to 6 percent slopes
597	Emrick-Heimdal loams, 0 to 3 percent slopes
753	Fram-Wyard loams, 0 to 3 percent slopes (where drained)
763	Gardena loam, 0 to 3 percent slopes
781	Gilby loam
796	Glyndon loam
866	Hamerly loam, 3 to 6 percent slopes
881	Hamerly-Tonka complex, 0 to 3 percent slopes (where drained)
884	Hamerly-Wyard loams, 0 to 3 percent slopes (where drained)
988	Heimdal-Emrick loams, 3 to 6 percent slopes
1057	LaDelle silt loam, 0 to 3 percent slopes
1062	LaDelle silty clay loam, 0 to 3 percent slopes
1092	Lankin loam
1267	Marysland loam (where drained)
1404	Overly silty clay loam, 0 to 3 percent slopes
1762	Svea-Barnes loams, 0 to 3 percent slopes
1765	Svea-Buse loams, 3 to 6 percent slopes
1780	Swenoda fine sandy loam
2154	Glyndon-Tiffany loams
2158	Velva fine sandy loam, 0 to 6 percent slopes
2159	Walsh silty clay loam, 1 to 6 percent slopes
2160	Wyndmere-Tiffany complex, silty substratum (where drained)

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Douglas A. Gasseling, conservation agronomist, and Noel R. Asp, soil conservation technician, Natural Resources Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Natural Resources Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the North Dakota Cooperative Extension Service.

About 88 percent of Steele County is cultivated. In 1990, about 259,900 acres was used for close-grown crops, 92,000 acres for row crops, and 7,000 acres for forage crops *(15)*. The acreage of summer fallow was 70,000 acres in 1988; 35,000 acres in 1989; and 45,000 acres in 1990. The acreage used for sunflowers has fluctuated. It averaged 21,900 acres per year from 1985 to 1989. It was 18,000 acres in 1988 and 17,000 acres in 1989. The acreage used for corn and forage has been relatively stable in recent years. In 1990, the acreages of the principal close-grown crops were as follows—spring wheat, 170,000 acres; durum wheat, 5,500 acres; winter wheat, 1,000 acres; barley, 78,000 acres; oats, 3,000 acres; rye, 100 acres; and flax, 1,300 acres. The main row crops were sunflowers, soybeans, dry beans, and corn. Sunflowers were grown on 21,000 acres, corn for grain on 6,400 acres, and corn for silage on 1,600 acres. Alfalfa was grown on 1,500 acres and other hay crops on 5,500 acres. Small acreages were planted to mustard, buckwheat, lentils, millet, and safflower. In 1990, approximately 54,425 acres was enrolled in the Conservation Reserve Program.

The potential of the soils in Steele County for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate in Steele County are suited to most of the crops that are commonly grown in the county. The crops that are not commonly grown but are suitable include potatoes and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper utilization of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on about half of the soils in Steele County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Arvilla, Binford, Coe, Egeland, Embden, Hecla, Kratka, Maddock, Swenoda, Velva, and Wyndmere soils.

Antler, Arveson, Bearden, Buse, Colvin, Divide, Esmond, Fram, Gilby, Glyndon, Hamerly, Lamoure, Marysland, Rauville, Vallers, and Zell soils have a relatively high content of lime and are susceptible to soil blowing in spring if they have been left unprotected throughout winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are left unprotected.

Water erosion is a severe hazard on gently rolling or moderately sloping and steeper soils, such as Barnes, Buse, Edgeley, Esmond, Heimdal, Kloten, Overly, Svea, and Zell soils. The hazard is greatest when the surface is left unprotected.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of approved herbicides can help to eliminate the need for summer fallow tillage. Cover crops also are effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. Inclusion of grasses and legumes in the cropping sequence, grassed waterways, diversions, terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that includes several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to the success of the crop during the growing season. In years when the amount of available soil moisture is low at planting time, the success of cropping is greatly reduced. Measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds conserve moisture. Examples are stubble mulching; mulch tillage; no-till farming; stripcropping; cover crops; crop residue management; standing stubble, which traps snow; and applications of fertilizer. When fallow is used to carry moisture over to the next season, a cover of crop residue is essential during winter to guard against moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on many soils. Examples are applications of commercial fertilizer, green manure crops, inclusion of legumes in the cropping sequence, and applications of barnyard manure.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on Aberdeen, Cavour, Cresbard, and Miranda soils, which have a sodic subsoil, and on Antler, Bearden, LaDelle, Overly, Parnell, Perella, Southam, and Walsh soils, which have a surface layer of clay loam or silty clay loam. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases the susceptibility to erosion.

Management of Saline and Sodic Soils

Saline and sodic soils make up 3.3 percent of Steele County. Saline soils make up 2.4 percent of the county, or about 11,035 acres; sodic soils make up 0.8 percent, or about 3,910 acres; and saline-sodic soils make up 0.1 percent, or about 625 acres.

Saline soils have a high concentration of soluble salts, or salts that dissolve in water. The saline soils in Steele County are phases of the Antler, Colvin, Hamerly, and Vallers series.

Saline soils generally develop in areas of restricted drainage, such as those adjacent to sloughs and drainageways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by plants and a surface cover. The plant roots use the water in the soil before it can reach the surface and before the salts accumulate. The surface cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the water in the soil. Excess amounts of certain salts can interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause

nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts generally are not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts are usually visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain crop growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can be used for salt-tolerant crops and forage. Barley is the most salt tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt tolerant once they are established. Cropping year after year is beneficial because it uses the water available to plants each year, reduces the evaporation rate, and minimizes the accumulation of salts in the surface layer.

Sodic soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soils. The sodic soils in Steele County are phases of the Aberdeen, Cavour, and Cresbard series. Locally, sodic soils are known as "alkali" or "gumbo."

Sodic soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the sodic soils and the surrounding soils is only a few feet, perhaps 5 to 10 feet.

Sodic soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, rainwater gradually leaches the salts from the surface to the lower horizons as the water table lowers. During this leaching process, the clay in the soils becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, sodic subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. Cavour soils are an example of soils that have a dense, sodic subsoil.

As leaching by water in the soils continues, the sodium is gradually moved lower in the soil profile and eventually is carried below the rooting depth. The result is a more manageable soil. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonsodic soil. This change requires a long period, usually centuries *(6)*.

If plowed, sodic soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils do not favor plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by depth to the dense subsoil.

Identification of sodic soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of moisture stress, is a useful indicator of the level of sodicity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of sodicity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effect of sodicity on plant growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the growth of these crops.

The variability of sodic soils can cause management problems. The soils that have a dense, sodic subsoil near the surface, such as Cavour soils, are better suited to grasses than to small grain and sunflowers.

Timely tillage is an important management need in areas of sodic soils. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when too dry, tillage and seeding implements cannot easily penetrate the surface. Deep plowing and chemical amendments can help to reclaim sodic soils, but they may not be feasible. To be effective, deep tillage should reach to the sodic subsoil and mix several inches of the underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of sodic soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-sodic soils develop in areas of restricted drainage where salts rise with the water table but where some leaching downward of clay and some saturation with sodium are evident and a dense, sodic subsoil has formed. The saline-sodic soils in Steele County are those of the Miranda series. The management needs and crop responses on these soils are a combination of

those on saline soils and those on sodic soils.

Additional information about management or reclamation of saline and sodic soils is available from the Natural Resources Conservation Service, the North Dakota Agricultural Experiment Station, and the North Dakota Cooperative Extension Service.

Pasture Groups

The following paragraphs describe the pasture groups in the survey area. They specify the production potential under improved management and the representative adapted forage species for each group. The names of these groups are Clayey Subsoil, Claypan, Limy Subirrigated, Loamy and Silty, Moderately Deep Silty, Overflow and Run-on, Saline, Sands, Sandy, Shallow to Gravel, Thin Claypan, Thin Upland, Very Shallow to Gravel, and Wet.

Clayey Subsoil pasture group. This group of soils has a subsoil that somewhat restricts root penetration. The production potential is moderately high. Suitable forage species include smooth bromegrass, Russian wildrye, western wheatgrass, green needlegrass, switchgrass, alfalfa, and sweetclover.

Claypan pasture group. This group of soils has a dense subsoil that restricts root penetration. The production potential is low. Suitable forage species include western wheatgrass, tall wheatgrass, intermediate wheatgrass, pubescent wheatgrass, slender wheatgrass, alfalfa, and sweetclover.

Limy Subirrigated pasture group. This group of soils has a highly calcareous subsoil. The production potential is high. Suitable forage species include big bluestem, indiangrass, switchgrass, little bluestem, smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, tall wheatgrass, slender wheatgrass, sweetclover, and birdsfoot trefoil.

Loamy and Silty pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of silt and clay and a low content of sand. The production potential is high. Suitable forage species include smooth bromegrass, Russian wildrye, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, switchgrass, indiangrass, big bluestem, slender wheatgrass, streambank wheatgrass, alfalfa, and sweetclover.

Moderately Deep Silty pasture group. This group of soils has a substratum that restricts root penetration at a depth of about 20 to 40 inches. The soils have a relatively high content of silt and clay. The production potential is moderately high. Suitable forage species include smooth bromegrass, Russian wildrye, intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, western wheatgrass, slender wheatgrass, green needlegrass, sideoats grama, alfalfa, and sweetclover.

Overflow and Run-on pasture group. This group of soils is in areas that receive additional moisture because of stream overflow or runoff from the surrounding areas. The production potential is high. Suitable forage species include smooth bromegrass, meadow bromegrass, intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, altai wildrye, western wheatgrass, thickspike wheatgrass, green needlegrass, slender wheatgrass, big bluestem, indiangrass, switchgrass, alfalfa, and sweetclover.

Saline pasture group. This group of soils has enough salts to interfere with plant growth. Wetness is a problem. Severely affected areas can be improved, particularly during the establishment period, by mulch, which reduces the extent of surface drying and improves seedling emergence. The better suited forage species include tall wheatgrass, slender wheatgrass, western wheatgrass, beardless wildrye, alkali sacaton, alsike clover, and sweetclover.

Sands pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of sand and a low content of silt and clay. The production potential is moderately high. Suitable forage species include sand bluestem, prairie sandreed, switchgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Sandy pasture group. This group of soils has a subsoil that is permeable to roots. The soils have a relatively high content of sand and a moderate content of silt and clay. The production potential is high. Suitable forage species include green needlegrass, slender wheatgrass, western wheatgrass, intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, sand bluestem, switchgrass, alfalfa, and sweetclover.

Shallow to Gravel pasture group. This group of soils has a substratum that has a relatively high content of sand or of sand and gravel at a depth of about 14 to 25 inches. The production potential is moderate. Drought-tolerant forage species grow best. Suitable species include crested wheatgrass, green needlegrass, western wheatgrass, slender wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

Thin Claypan pasture group. This group of soils has

a very dense subsoil that severely restricts root penetration and has enough salts to interfere with plant growth. The production potential is very low. The best suited forage species include western wheatgrass, slender wheatgrass, and alfalfa.

Thin Upland pasture group. This group of soils is in areas that allow runoff of precipitation. The soils have a highly calcareous subsoil. Soil blowing and water erosion are management concerns, particularly during the establishment period. The production potential is moderate. Suitable forage species include smooth bromegrass, intermediate wheatgrass, pubescent wheatgrass, western wheatgrass, green needlegrass, little bluestem, prairie sandreed, sideoats grama, sweetclover, and alfalfa.

Very Shallow to Gravel pasture group. This group of soils has a substratum that has a high content of sand or of sand and gravel within a depth of 14 inches. The production potential is low. The most drought-tolerant forage species grow best. Suitable species include western wheatgrass, crested wheatgrass, green needlegrass, intermediate wheatgrass, and pubescent wheatgrass.

Wet pasture group. This group of soils is wet. The production potential is very high. The best suited forage species are those that are tolerant of wetness and inundation. Suitable species include reed canarygrass, creeping foxtail, big bluestem, switchgrass, indiangrass, meadow foxtail, and alsike clover.

Yields per Acre

The average yields per acre that can be expected of the principal crops either under a high level of management or as otherwise indicated are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Natural Resources Conservation Service or of the North Dakota Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison to other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. On the Central Black Glaciated Plains, in the western part of Steele County, a productivity index of 100 was considered equal to an average yield of 40 bushels per acre of spring wheat. In the Red River Valley of the North, in the eastern part of the county, a productivity index of 100 was considered equal to an average yield of 45 bushels per acre of spring wheat. On the Central Black Glaciated Plains, Svea-Barnes loams, 0 to 3 percent slopes, for example, has a productivity index of 91, which when multiplied by 40 and then divided by 100, converts to 36, which is the expected average annual yield of spring wheat in bushels per acre for this map unit. In the Red River Valley of the North, Bearden-Perella silty clay loams has a productivity index of 92, which when multiplied by 45 and then divided by 100, converts to 41, which is the expected average annual yield of spring wheat in bushels per acre for this map unit. (See table 5.)

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management *(11)*. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major

reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of the map units in this survey area is given in the section "Detailed Soil Map Units."

Rangeland

A. Dean Chamrad and Jeffrey L. Printz, range conservationists, Natural Resources Conservation Service, helped prepare this section.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments, such as applications of fertilizer and cultivation, generally are not used or needed to maintain the productivity of rangeland. The composition and production of the plant community are largely determined by soil, climate, topography, and grazing management.

In 1990, approximately 27,000 acres in Steele County, or about 6 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Nearly all of the soils in the county are suited to rangeland. Most of the rangeland, however, is in a few areas of strongly sloping to steep soils. These are Buse-Barnes loams, 9 to 15 percent slopes; Buse-Barnes loams, 15 to 35 percent slopes; Coe-Binford complex, 6 to 25 percent slopes; Edgeley-Kloten-Esmond complex, 9 to 35 percent slopes; and Esmond-Heimdal loams, 9 to 15 percent slopes. These soils are generally unsuited to cultivated crops because of the slope. The Coe-Binford complex is generally unsuited because of a very low or low available water capacity.

In 1990, the farms and ranches in the county had about 4,000 head of cattle, including about 200 milk cows and 1,000 sheep *(15)*. Most of the farms and ranches include a cow-calf enterprise. Some also run stocker yearlings, which add flexibility during periods of low or high forage production. On a few of the farms, raising sheep in conjunction with cattle improves the efficiency of range utilization and results in greater economic stability.

Because of a relatively short growing season, some farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in spring and fall. Droughts of short duration are common. They reduce the benefits derived from cool-season pastures in some years. Generally, large amounts of hay and feed are needed because of long winters. Hay was harvested on about 7,000 acres in the county in 1990 *(15)*.

Range Site and Condition Classes

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of

soil. Effective management is based on the relationships among soils, vegetation, and water.

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce similar kinds, proportion, and amounts of vegetation are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. The climax vegetation on the prairie consists of the kinds of plants that grew when the region was settled. It is generally, but not always, the most productive combination of plants that can be grown on the site. When the site is improperly grazed, some of the climax plants decrease in quantity, while others increase. Also, plants that were not part of the original native plant community may invade the site.

Decreaser plants are the species that decline in quantity under continuous heavy grazing. They generally are the most palatable to livestock.

Increaser plants are the species that initially increase in quantity under continuous heavy grazing at the expense of the decreaser species. They generally are less palatable to livestock than the decreaser species. Under prolonged heavy grazing, the increaser plants also eventually decrease in quantity.

Invader plants are species that normally are not part of the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by continuous heavy grazing or another disturbance. Most invader species have limited value as forage. All nonendemic species are invaders in natural plant communities.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the higher the range condition. Range condition is an ecological rating only. It is not a rating of forage value. It is expressed as excellent, good, fair, or poor, depending on how closely the present plant community resembles the natural potential plant community. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition, the vigor of the plants, and the amount of moisture available to the plants during the growing season.

Table 6 shows, for those soils in the county that are used as rangeland, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. An explanation of the column headings in table 6 follows:

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range sites. Soil reaction, salt content, and a seasonal high water table also are important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, regardless of palatability to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. Production is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially above average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture or above average temperatures.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as kind of plant, state of growth, exposure, amount of shade, recent rains, and unseasonably dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition and trend. The primary objective in range management is to manipulate grazing in such a manner that the plants growing on a site are similar in kind and amount to the potential natural plant community for that site. Such management generally results in the optimum production and diversity of vegetation, suppression of undesirable brush and weeds, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat

below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Ecologically sound range management maintains excellent or good range condition. Water is conserved, yields are optimized, and soils are protected. An important management concern is recognizing the changes in the plant community that take place gradually and that can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when the plant cover actually is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and a grazing system to restore the rangeland to excellent condition. In areas where the climax plant community has been destroyed, range seeding can accelerate improvement of the range condition. Seeding the proper climax species also can restore productive rangeland in areas of depleted or low-quality cropland. Brush control, water developments, fencing, and other mechanical practices may be needed to facilitate proper grazing management. Proper grazing management is the key to maintaining or improving the productivity and diversity of rangeland.

The following paragraphs describe the range sites in the county. The names of these sites are Shallow, Shallow to Gravel, Silty, Thin Upland, and Very Shallow.

Shallow range site. The principal grasses on this site are little bluestem, needleandthread, western wheatgrass, plains muhly, blue grama, and sideoats grama. Grasses make up about 75 percent of the vegetation. Upland sedges make up about 10 percent. Forbs, such as blacksamson, hairy goldaster, skeletonweed, purple prairie-clover, and stiff sunflower, also make up about 10 percent. Shrubs, such as western snowberry and prairie rose, make up the rest.

Continual heavy grazing by cattle results in a decrease in the abundance of little bluestem, needleandthread, sideoats grama, prairie sandreed, and stiff sunflower. Initially, needleandthread tends to increase in abundance, but it then decreases. Blue grama, upland sedges, red threeawn, and fringed sagewort increase in abundance. Further deterioration results in the dominance of blue grama, upland sedges, fringed sagewort, and unpalatable forbs.

A low available water capacity limits forage production on this site. Water erosion is a hazard in areas that have a slope of more than about 5 percent. Gullies form readily along cattle trails and in denuded areas. Management practices that maintain the key plants and control the pattern of livestock traffic help to maintain productivity. Planned grazing systems and proper grazing use are essential in restoring or maintaining the productivity of the site.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid and short grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are plains muhly, prairie junegrass, porcupinegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama and upland sedges. Further deterioration results in the dominance of blue grama, upland sedges, fringed sagewort, and annual forbs.

A low available water capacity limits forage production on this site. The site is fragile, and the plant community can deteriorate rapidly. Keeping the plant community near its potential and maintaining the vigor of the key plants help to optimize the use of the limited amount of available moisture.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, green needlegrass, needleandthread, and blue grama. Other species are prairie junegrass, prairie dropseed, and upland sedges. Forbs include wooly goldenrod, stiff sunflower, and western yarrow. The site has minor amounts of woody species.

Continual heavy grazing by cattle results in a decrease in the abundance of green needlegrass, western wheatgrass, prairie junegrass, and porcupinegrass. The plants that increase in abundance under these conditions are needleandthread, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagewort. Further deterioration results in the dominance of blue grama, threadleaf sedge, needleleaf sedge, fringed sagewort, green sagewort, and other forbs. As the range site deteriorates, woody species increase in abundance and Kentucky bluegrass invades.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Proper grazing use and

planned grazing systems help to prevent gullying. Areas where the range is in fair or poor condition generally can be restored to good or excellent condition by sound grazing management. Brush control is needed in areas where undesirable woody species have increased in abundance or invaded.

Thin Upland range site. Cool- and warm-season, mid grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and sideoats grama. Other species are plains muhly, blue grama, prairie dropseed, bearded wheatgrass, and upland sedges. Forbs include pasqueflower, purple prairie-clover, blacksamson, and dotted gayfeather. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, upland sedges, and unpalatable forbs. Further deterioration results in the dominance of blue grama, upland sedges, and fringed sagewort; the invasion of Kentucky bluegrass; and an increase in the abundance of woody species.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Gullying can be prevented by proper grazing management and by cross-fencing, which helps to control livestock traffic patterns. Soil blowing is a problem in denuded areas. Areas where the range is in fair or poor condition generally can be restored to good or excellent condition by sound grazing management. In some areas brush control is needed.

Very Shallow range site. This site has a mixture of cool- and warm-season, mid and short grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species are prairie junegrass, sideoats grama, and upland sedges. Woody plants and forbs, including scarlet globemallow and silverleaf scurfpea, make up about 15 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, sand dropseed, and upland sedges. Further deterioration results in the dominance of blue grama, upland sedges, fringed sagewort, broom snakeweed, and annual forbs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can readily form along cattle trails and in denuded areas. The site is frequently spot grazed. Once it has deteriorated to fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by sound grazing management of the mid grasses.

Woodland, Windbreaks, and Environmental Plantings

Prepared by Bruce C. Wight and Susan B. Hart, foresters, Natural Resources Conservation Service.

Steele County has approximately 3,600 acres of native woodland *(8)*. Most of this woodland is in the valleys around the North and Middle Branches of the Goose River and their tributaries. The woodland on the side slopes of the river valleys is primarily in areas of Zell soils. The woodland on bottom land is mainly in areas of LaDelle and Velva soils.

The forest type on bottom land is primarily green ash and American elm. The less common species include cottonwood, boxelder, bur oak, American basswood, ironwood, and various species of willow. The understory vegetation includes redosier dogwood, nannyberry viburnum, gooseberry, and woods rose.

The forest type on the side slopes of the river valleys is primarily green ash and bur oak. Green ash dominates on the lower slopes, and bur oak dominates on the upper slopes. Quaking aspen grows in the areas on side slopes that are moist or seepy. The understory vegetation consists of hawthorn, buffaloberry, silverberry, alder buckthorn, and gooseberry.

The early settlers used the trees for fuel, lumber, and fenceposts. Currently, there is a renewed interest in using the trees for fuel, but the principal uses are for protection and esthetic purposes. The trees protect the soils, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in Steele County since the early days of settlement. Most of the early plantings were made to protect farmsteads and livestock. In the 1930's, approximately 590 acres was planted to trees and shrubs under the Prairie States Forestry Project of the United States Department of Agriculture, Forest Service.

Since the 1930's, more than 3,465,000 trees have been planted on about 4,700 acres by county farmers and landowners assisted by the Natural Resources Conservation Service and the Steele County Soil Conservation District. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help protect soils that are highly susceptible to soil blowing.

The following items should be considered before a planting is made—the purpose of the planting, the suitability of the soils for the various species of trees and shrubs, the location and design of the windbreak, and the selection of hardy seedlings. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the trees and shrubs are planted, and the ground cover should be controlled for the life of the windbreak. Some replanting may be necessary during the first 2 years after the trees and shrubs are planted.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Natural Resources Conservation Service or the North Dakota Cooperative Extension Service or from a commercial nursery.

Recreation

Prepared by David D. Dewald, biologist, Natural Resources Conservation Service.

The recreational resources of Steele County are somewhat limited. Hunting and fishing are the main recreational opportunities available to the residents of the county. Opportunities for fishing are available at North Golden Lake and Golden Lake. Northern pike, walleye, bluegill, muskellunge, crappie, and perch are the main species of game fish in the waters.

Two towns in the county have picnicking and limited camping facilities. Areas around Golden Lake have camping, picnicking, and boat-rental facilities.

Approximately 3,250 acres managed by the U.S. Fish and Wildlife Service for waterfowl production provides opportunities for hunting. The North Dakota State Game and Fish Department manages approximately 4,800 acres of wildlife areas. Many private landowners grant permission to hunt on their land.

The public areas in the county provide opportunities for numerous other recreational activities, including hiking, bird-watching, and cross-country skiing.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to

flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Prepared by David D. Dewald, biologist, Natural Resources Conservation Service.

Most of Steele County is in the prairie pothole region of North Dakota. The eastern third, however, is on the Lake Agassiz Plain. The county has diverse kinds of wildlife habitat. Since settlement, agricultural activity has reduced the quality and quantity of rangeland and wetland wildlife habitat but has increased the amount of openland wildlife habitat. About 5 percent of the original rangeland habitat remains. The diversity of wildlife habitat is enhanced by the numerous wetlands in the county. Drainage systems installed to improve crop production have removed approximately 40 percent of the original wetland habitat. The remaining wetlands provide habitat for waterfowl and furbearers.

By 1987, private landowners had planted more than 4,500 acres of field and farmstead windbreaks, which provide habitat for resident and migratory wildlife species. Also, private landowners have protected approximately 3,900 acres of wetlands by conveying their drainage rights to the Federal Government through the Small Wetlands Acquisition Program. The landowners manage additional areas of upland and wetland primarily for wildlife. The expanded use of no-till farming and other conservation tillage systems and the inclusion of grasses and legumes in the cropping system have increased the amount of food and cover for migratory waterfowl and resident wildlife.

The public lands in Steele County provide excellent wildlife habitat. About 3,250 acres is managed by the U.S. Fish and Wildlife Service for waterfowl production. The North Dakota State Game and Fish Department manages approximately 4,800 acres of wildlife areas.

Important game bird species in the county are gray partridge, ducks, geese, mourning dove, and sharp-tailed grouse. The mammals that are hunted in the county include red fox, coyote, white-tailed deer, muskrat, mink, raccoon, badger, cottontail rabbit, and white-tailed jackrabbit.

A variety of fish species inhabits the waters in the county. Northern pike, walleye, perch, bluegill, muskellunge, and crappie are the major species. Most of the fish are in the lakes. The potential for developing additional fishery resources is limited.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are sunflowers, corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate wheatgrass, tall wheatgrass, smooth bromegrass, sweetclover, alsike clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are big bluestem, goldenrod, green needlegrass, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, snowberry, and buffaloberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include gray partridge, pheasant, western meadowlark, field sparrow, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, moose, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, deer, western meadowlark, and grasshopper sparrow.

About 53,500 acres in Steele County, or nearly 12 percent of the total acreage, meets the requirements for hydric soils. The map units in the county that display hydric characteristics are listed in this section. Areas that have been artificially drained or otherwise so altered that they no longer support a predominance of hydrophytic vegetation are not identified as hydric soils. The list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location of each is shown on the detailed maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

64	Arveson loam
450	Colvin silt loam
452	Colvin silt loam, saline
881	Hamerly-Tonka complex, 0 to 3 percent slopes (Tonka part)
1031	Kratka fine sandy loam
1267	Marysland loam
1427	Parnell silty clay loam
1710	Southam silty clay loam
1883	Vallers-Parnell complex
1886	Vallers and Hamerly loams, saline, 0 to 3 percent slopes (Vallers part)
2156	Lamoure and Rauville silt loams
2160	Wyndmere-Tiffany complex, silty substratum

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use

planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a

high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as the final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a

depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, and sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large

stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The

sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine

sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information about flooding is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the

extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(12)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has a udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(14)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(12)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Aberdeen Series

The Aberdeen series consists of very deep, moderately well drained, slowly permeable, sodic soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes are 0 to 1 percent.

Typical pedon of Aberdeen silty clay loam, 300 feet north and 2,450 feet west of the southeast corner of sec. 25, T. 146 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard and firm; slightly sticky and plastic; neutral; clear smooth boundary.

BE—8 to 12 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) silty clay loam, dark grayish brown (10YR 4/2) in the B part and grayish brown (10YR 5/2) in the E part dry; weak coarse subangular blocky structure parting to weak medium platy and weak fine angular blocky; slightly hard and firm; sticky and plastic; gray (10YR 5/1) uncoated silt grains on faces of peds; neutral; clear wavy boundary.

Btn1—12 to 17 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to strong fine angular blocky; hard and firm; very sticky and very plastic; many distinct clay films on faces of peds and lining pores; neutral; clear wavy boundary.

Btn2—17 to 23 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate fine angular blocky; hard and firm; very sticky and very plastic; common faint clay films on faces of peds and lining pores; neutral; clear smooth boundary.

Bky—23 to 39 inches; light olive brown (2.5Y 5/4) silty clay loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard and firm; sticky and plastic; many medium nests of gypsum; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—39 to 56 inches; light yellowish brown (2.5Y 6/4) silty clay loam, light gray (2.5Y 7/2) dry; common fine distinct light gray (2.5Y 7/2) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard and friable; sticky and plastic; few medium nests of gypsum crystals; strong effervescence; slightly alkaline; clear smooth boundary.

C2—56 to 60 inches; light olive brown (2.5Y 5/4) silt loam stratified with layers of silty clay loam and very fine sandy loam 1 to 10 millimeters thick; pale yellow (2.5Y 7/4) dry; common fine distinct light brownish gray (2.5Y 6/2) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 25 inches. The depth to gypsum and other salts ranges from 16 to 40 inches.

The Ap horizon has value of 2 or 3 (3 or 4 dry). The BE horizon has chroma of 1 or 2. Some pedons have an E or B/E horizon. The Btn horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. It is silty clay, silty clay loam, or clay. Some pedons have a Btk horizon. The Bky horizon has value of 3 to 5 (5 to 7 dry). It is silty clay loam or silt loam. Some pedons have a BCk horizon. The C horizon has value of 4 to 6 (5 to 8 dry).

Antler Series

The Antler series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits and glacial till. Slopes are 0 to 1 percent.

Typical pedon of Antler clay loam, 1,700 feet east and 1,750 feet north of the southwest corner of sec. 2, T. 148 N., R. 55 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; sticky and plastic; common very fine roots; slight effervescence; slightly alkaline; clear smooth boundary.

Bk1—9 to 22 inches; dark gray (10YR 4/1) clay loam, gray (10YR 6/1) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard and friable; sticky and plastic; few very fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

2Bk2—22 to 28 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; sticky and plastic; few very fine roots; about 5 percent gravel; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

2By1—28 to 36 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct grayish brown (2.5Y 5/2) and few medium prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly hard and friable; sticky and plastic; about 5 percent gravel; common medium nests of gypsum crystals; strong effervescence; moderately alkaline; gradual wavy boundary.

2By2—36 to 44 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; many

medium and fine prominent gray (10YR 5/1) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard and friable; sticky and plastic; about 5 percent gravel; common medium nests of gypsum crystals; strong effervescence; moderately alkaline; clear wavy boundary.

2C—44 to 60 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; many medium and fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard and friable; sticky and plastic; about 2 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. In some pedons the soils are saline.

The Ap horizon has value of 2 or 3 (3 or 4 dry). Some pedons have an Ak or Az horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 to 3. It is clay loam or silty clay loam. Some pedons have a Bkyz or Bky horizon. The 2Bk horizon has value of 5 or 6 (6 to 8 dry). Some pedons have a 2Bky horizon. The 2C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. It is loam or clay loam.

Arveson Series

The Arveson series consists of very deep, poorly drained, highly calcareous soils on delta plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Arveson loam, 985 feet north and 1,430 feet west of the southeast corner of sec. 10, T. 146 N., R. 54 W.

Ak—0 to 11 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak medium and fine granular structure; soft and very friable; slightly sticky and slightly plastic; many fine and very fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

ABkg—11 to 18 inches; very dark gray (5Y 3/1) loam, gray (5Y 5/1) dry; weak medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few medium and common very fine and fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

Bkg—18 to 26 inches; dark gray (5Y 4/1) fine sandy loam, light gray (5Y 6/1) dry; weak medium and fine subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—26 to 35 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard and very friable; slightly sticky and nonplastic; strong effervescence; slightly alkaline; clear smooth boundary.

C2—35 to 49 inches; olive gray (5Y 5/2) fine sand, light gray (5Y 7/2) dry; few fine and medium prominent yellowish brown (10YR 5/4) and few fine prominent brown (7.5YR 4/4) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; slightly alkaline; clear wavy boundary.

C3—49 to 60 inches; olive gray (5Y 5/2) fine sand, light gray (5Y 7/2) dry; many medium and coarse prominent dark yellowish brown (10YR 4/6), common medium and coarse prominent brown (7.5YR 4/4), and few fine prominent dark brown (7.5YR 3/2) mottles; single grain; loose; nonsticky and nonplastic; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The Ak horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. The Bkg horizon has hue of 10YR to 5Y, value of 3 to 7 (4 to 8 dry), and chroma of 1 or 2. It is dominantly fine sandy loam, loam, or clay loam, but the lower part is loamy sand or loamy fine sand in some pedons. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 1 or 2. It is fine sand, loamy fine sand, or fine sandy loam.

Arvilla Series

The Arvilla series consists of very deep, somewhat excessively drained soils on delta plains. These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 6 percent.

Typical pedon of Arvilla sandy loam, 0 to 6 percent slopes, 1,170 feet west and 1,290 feet north of the southeast corner of sec. 2, T. 146 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; soft and very friable; slightly sticky and nonplastic; many very fine and fine roots; about 1 percent gravel; neutral; abrupt smooth boundary.

Bw1—8 to 12 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; soft and very friable; slightly sticky and nonplastic; many very fine and

fine roots; about 2 percent gravel; neutral; clear wavy boundary.

Bw2—12 to 17 inches; dark yellowish brown (10YR 3/4) sandy loam, dark yellowish brown (10YR 4/4) dry; weak medium prismatic structure parting to weak fine subangular blocky; soft and very friable; slightly sticky and nonplastic; common very fine roots; about 8 percent gravel; neutral; clear smooth boundary.

2Bk—17 to 28 inches; grayish brown (10YR 5/2) gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; common coatings of lime on the bottom of pebbles; slight effervescence; slightly alkaline; gradual wavy boundary.

2C—28 to 60 inches; grayish brown (10YR 5/2) gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose; nonsticky and nonplastic; about 17 percent gravel; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to sand and gravel ranges from 14 to 25 inches.

The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (3 to 5 dry). Some pedons do not have a 2Bk horizon. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It has 5 to 35 percent gravel. It is dominantly gravelly coarse sand, gravelly sand, coarse sand, sand, or loamy sand. In some pedons, however, it has thin strata of very gravelly coarse sand.

Barnes Series

The Barnes series consists of very deep, well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slopes range from 0 to 25 percent.

Typical pedon of Barnes loam, in an area of Barnes-Buse loams, 3 to 6 percent slopes, 390 feet west and 1,630 feet north of the southeast corner of sec. 31, T. 144 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; clear smooth boundary.

Bw1—7 to 11 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak coarse and medium subangular blocky; slightly hard and friable; sticky and plastic; few very fine roots; about 2 percent gravel; slightly alkaline; clear smooth boundary.

Bw2—11 to 18 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; sticky and plastic; few very fine roots; about 2 percent gravel; slightly alkaline; gradual wavy boundary.

Bk—18 to 36 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse subangular blocky structure; slightly hard and firm; sticky and plastic; about 5 percent gravel; few medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

BCk—36 to 48 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard and firm; sticky and plastic; about 5 percent gravel; common medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual smooth boundary.

C—48 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard and firm; sticky and plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 5 (3 to 6 dry) and chroma of 2 to 4. The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. Some pedons do not have a BCk horizon. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. It is loam or clay loam.

Bearden Series

The Bearden series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes are 0 to 1 percent.

Typical pedon of Bearden silty clay loam, in an area of Bearden-Perella silty clay loams, 2,165 feet south and 2,480 feet west of the northeast corner of sec. 8, T. 147 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard and firm; sticky and plastic; many very fine and fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

ABk—8 to 12 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium

subangular blocky structure; hard and firm; sticky and plastic; many fine and very fine roots; common seams and irregularly shaped masses of lime; strong effervescence; slightly alkaline; clear irregular boundary.

Bk—12 to 17 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard and firm; sticky and plastic; common fine and very fine roots; many fine and medium irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bky1—17 to 25 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; few medium distinct light brownish gray (2.5Y 6/2) mottles; weak coarse subangular blocky structure; hard and firm; sticky and plastic; common very fine roots; few medium nests of gypsum crystals; common irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bky2—25 to 37 inches; olive brown (2.5Y 4/4) silty clay loam, light olive brown (2.5Y 5/4) dry; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; hard and firm; sticky and plastic; few very fine roots; few medium nests of gypsum crystals; few irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C1—37 to 45 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent brownish yellow (10YR 6/6) and many medium distinct light brownish gray (2.5Y 6/2) mottles; massive; slightly hard and firm; sticky and plastic; strong effervescence; slightly alkaline; gradual smooth boundary.

C2—45 to 52 inches; light olive brown (2.5Y 5/4) silty clay loam and silt loam, pale yellow (2.5Y 7/4) dry; many medium distinct light gray (2.5Y 7/2) and many fine prominent brownish yellow (10YR 6/6) mottles; massive; slightly hard and firm; sticky and plastic; strong effervescence; slightly alkaline; clear smooth boundary.

C3—52 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; many medium and coarse distinct olive yellow (2.5Y 6/6), many medium distinct light brownish gray (2.5Y 6/2), and many fine prominent brown (7.5YR 4/4) mottles; massive; slightly hard and firm; sticky and plastic; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The Ap horizon has value of 2 or 3 (3 to 5 dry). Some pedons do not have an ABk horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 2 to 4. It is silty clay loam or silt loam. Some pedons do not have a Bky horizon. Some have a BCk horizon. The C horizon has value of 4 to 7 (5 to 8 dry) and chroma of 2 to 4.

Binford Series

The Binford series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Slopes range from 0 to 15 percent.

Typical pedon of Binford sandy loam, in an area of Binford-Coe sandy loams, 0 to 6 percent slopes, 1,750 feet east and 180 feet north of the southwest corner of sec. 26, T. 145 N., R. 55 W.

Ap—0 to 6 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; soft and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; about 5 percent shale in the 0.1- to 76-millimeter fraction; neutral; clear smooth boundary.

A—6 to 9 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak coarse and medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; about 5 percent shale in the 0.1- to 76-millimeter fraction; neutral; gradual wavy boundary.

Bw—9 to 15 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; soft and very friable; slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; about 10 percent shale in the 0.1- to 76-millimeter fraction; slightly alkaline; gradual smooth boundary.

2C1—15 to 21 inches; very dark grayish brown (2.5Y 3/2) very gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose; nonsticky and nonplastic; about 50 percent gravel; about 70 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline; abrupt smooth boundary.

2C2—21 to 25 inches; brown (10YR 5/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; about 15 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline; abrupt smooth boundary.

2C3—25 to 60 inches; dark grayish brown (2.5Y 4/2)

gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; about 55 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to sand and gravel ranges from 14 to 20 inches.

The A horizon has value of 2 or 3. The Bw horizon has value of 2 to 4 (4 to 6 dry) and chroma of 2 or 3. Some pedons have a 2Bk horizon. The 2C horizon has value of 5 to 7 dry and chroma of 2 to 4. It has 20 to 70 percent shale in the 0.1- to 76-millimeter fraction and has 5 to 35 percent gravel.

Brantford Series

The Brantford series consists of very deep, well drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Brantford loam, 0 to 3 percent slopes, 2,150 feet south and 165 feet east of the northwest corner of sec. 6, T. 147 N., R. 57 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; soft and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; about 5 percent shale in the 0.1- to 76-millimeter fraction; slightly alkaline; abrupt smooth boundary.

Bw1—9 to 14 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard and friable; sticky and slightly plastic; few very fine roots; about 5 percent gravel; about 7 percent shale in the 0.1- to 76-millimeter fraction; slightly alkaline; clear wavy boundary.

2Bw2—14 to 18 inches; dark grayish brown (2.5Y 4/2) gravelly sandy loam, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few very fine roots; about 30 percent gravel; about 30 percent shale in the 0.1- to 76-millimeter fraction; slightly alkaline; gradual wavy boundary.

2Bk—18 to 29 inches; very dark grayish brown (2.5Y 3/2) very gravelly loamy coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; about 30 percent shale in the 0.1- to 76-millimeter fraction; few coatings of lime on the bottom of pebbles; slight effervescence; moderately alkaline; gradual wavy boundary.

2C1—29 to 40 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; moderately alkaline; clear wavy boundary.

2C2—40 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 20 percent gravel; about 40 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to sand and gravel ranges from 14 to 20 inches.

The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 or 4 (4 or 5 dry) and chroma of 1 to 3. The 2Bw horizon has value of 5 or 6 dry and chroma of 2 or 3. It is gravelly sandy loam or gravelly loam. Some pedons do not have a 2Bw or 2Bk horizon. The 2C horizon has value of 3 to 6 and chroma of 2 to 4. The 2Bw, 2Bk, and 2C horizons have 20 to 70 percent shale in the 0.1- to 76-millimeter fraction and have 15 to 50 percent gravel.

Buse Series

The Buse series consists of very deep, well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slopes range from 3 to 35 percent.

Typical pedon of Buse loam, in an area of Barnes-Buse loams, 3 to 6 percent slopes, 390 feet west and 1,600 feet north of the southeast corner of sec. 31, T. 144 N., R. 57 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium and fine subangular blocky structure; soft and friable; sticky and plastic; few very fine roots; about 8 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—6 to 16 inches; brown (10YR 5/3) loam, very pale brown (10YR 7/3) dry; weak coarse subangular blocky structure; slightly hard and firm; sticky and plastic; few very fine roots; about 5 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—16 to 36 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak medium and coarse subangular blocky structure; slightly hard

and firm; sticky and plastic; about 5 percent gravel; common fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C1—36 to 42 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; soft and friable; slightly sticky and slightly plastic; about 5 percent gravel; slight effervescence; moderately alkaline; clear smooth boundary.

C2—42 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard and firm; sticky and plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The Ap horizon has value of 2 or 3 (4 or 5 dry). The Bk and C horizons are loam or clay loam. The Bk horizon has value of 4 to 6 (5 to 8 dry) and chroma of 2 to 4. The C horizon has value of 5 to 7 dry.

Cavour Series

The Cavour series consists of very deep, moderately well drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slopes range from 0 to 3 percent.

Typical pedon of Cavour loam, in an area of Cavour-Cresbard loams, 0 to 3 percent slopes, 1,050 feet west and 90 feet south of the northeast corner of sec. 4, T. 148 N., R. 57 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium and coarse subangular blocky structure; slightly hard and friable; sticky and plastic; common very fine roots; about 1 percent gravel; neutral; clear wavy boundary.

E—6 to 8 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure parting to weak thin platy; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; about 1 percent gravel; neutral; abrupt wavy boundary.

Btn—8 to 17 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; strong coarse columnar structure parting to strong medium angular blocky; very hard and firm; very sticky and very plastic; few very fine roots compressed on faces of peds; continuous prominent clay films on faces of peds and in pores; gray (10YR 5/1) uncoated sand and silt grains on the top of columns; about 2 percent gravel; moderately alkaline; gradual wavy boundary.

Btkyz—17 to 27 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate medium angular and subangular blocky; hard and firm; very sticky and very plastic; common faint clay films on faces of peds; about 5 percent gravel; few gypsum and other salt crystals; common irregularly shaped masses of lime; slight effervescence; strongly alkaline; gradual smooth boundary.

Bkyz—27 to 57 inches; light olive brown (2.5Y 5/3) loam, pale yellow (2.5Y 7/3) dry; few fine distinct light olive brown (2.5Y 5/6) and few fine prominent gray (5Y 5/1) mottles; massive; hard and firm; sticky and plastic; about 5 percent gravel; few gypsum and other salt crystals; few irregularly shaped masses of lime; strong effervescence; strongly alkaline; gradual wavy boundary.

C—57 to 60 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 7/4) dry; common medium prominent dark yellowish brown (10YR 4/6) and few fine prominent gray (10YR 6/1) mottles; massive; hard and firm; sticky and plastic; about 5 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 30 inches. The depth to gypsum and other salts ranges from 16 to 40 inches.

The Ap horizon has value of 2 or 3 (3 to 5 dry). Some pedons do not have an E horizon. The Btn horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. It is clay loam, silty clay, or silty clay loam. The Bkyz horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 or 3. Some pedons have a Bky horizon. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4. It is clay loam or loam.

Coe Series

The Coe series consists of very deep, excessively drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 25 percent.

Typical pedon of Coe sandy loam, in an area of Binford-Coe sandy loams, 0 to 6 percent slopes, 2,030 feet east and 320 feet north of the southwest corner of sec. 13, T. 146 N., R. 56 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) sandy loam, gray (10YR 5/1) dry; weak medium and fine granular structure; soft and friable; slightly sticky and nonplastic; common very fine roots; about 10 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bk—8 to 17 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2)

dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; about 35 percent shale in the 0.1- to 76-millimeter fraction; few coatings of lime on the bottom of pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—17 to 46 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; about 25 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline; clear smooth boundary.

C2—46 to 52 inches; grayish brown (2.5Y 5/2) gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 20 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline; clear smooth boundary.

C3—52 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 12 inches. The depth to sand and gravel ranges from 6 to 14 inches.

The Ap horizon has value of 2 or 3 (3 to 5 dry). It is sandy loam or gravelly sandy loam. The Bk horizon has value of 4 to 6 (6 or 7 dry). It is very gravelly loamy coarse sand or very gravelly coarse sand. Some pedons do not have a Bk horizon. The C horizon has value of 4 to 6 (5 to 7 dry). It is very gravelly coarse sand, gravelly coarse sand, or gravelly sand. The Bk and C horizons have 20 to 70 percent shale in the 0.1- to 76-millimeter fraction and have 35 to 65 percent gravel.

Colvin Series

The Colvin series consists of very deep, poorly drained, moderately slowly permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes are 0 to 1 percent.

Typical pedon of Colvin silt loam, 200 feet north and 385 feet west of the southeast corner of sec. 19, T. 146 N., R. 54 W.

Ap—0 to 8 inches; black (N 2/0) silt loam, very dark gray (N 3/0) dry; moderate fine granular structure; soft and friable; slightly sticky and slightly plastic; many very fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

ABk—8 to 12 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; violent effervescence; moderately alkaline; clear irregular boundary.

Bkg—12 to 32 inches; gray (5Y 5/1) silty clay loam, white (5Y 8/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard and firm; sticky and plastic; few very fine roots; violent effervescence; moderately alkaline; abrupt wavy boundary.

Cg1—32 to 36 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; few fine prominent light olive brown (2.5Y 5/6) mottles; massive; slightly hard and firm; sticky and plastic; about 2 percent fine gravel; strong effervescence; moderately alkaline; clear wavy boundary.

Cg2—36 to 43 inches; light olive gray (5Y 6/2) silt loam, light gray (5Y 7/2) dry; few fine prominent black (5YR 2.5/1) and common medium prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; strong effervescence; slightly alkaline; clear smooth boundary.

Cg3—43 to 60 inches; pale olive (5Y 6/3) silty clay loam and silt loam, pale yellow (5Y 7/3) dry; common medium prominent yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6) mottles; massive; hard and firm; slightly sticky and plastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. In some pedons the soils are saline.

The Ap horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. Some pedons do not have an ABk horizon. The Bkg horizon has hue of 10YR to 5Y, value of 3 to 7 (5 to 8 dry), and chroma of 1 or 2. It is silty clay loam or silt loam. Some pedons have a Bky or Bkz horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 to 3.

Cresbard Series

The Cresbard series consists of very deep, moderately well drained, slowly permeable, sodic soils on till plains. These soils formed in glacial till. Slopes range from 0 to 3 percent.

Typical pedon of Cresbard loam, in an area of Cavour-Cresbard loams, 0 to 3 percent slopes, 465 feet east and 2,620 feet north of the southwest corner of sec. 6, T. 145 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; neutral; clear smooth boundary.

E—8 to 10 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure parting to weak medium platy; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; neutral; clear smooth boundary.

B/E—10 to 12 inches; clay loam that is black (10YR 2/1) in the B part and very dark gray (10YR 3/1) in the E part, very dark gray (10YR 3/1) in the B part and gray (10YR 5/1) in the E part dry; moderate medium and fine subangular and angular blocky structure; slightly hard and firm; sticky and plastic; common very fine roots; gray (10YR 5/1) silt and sand coatings on faces of peds; neutral; clear wavy boundary.

Btn1—12 to 16 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to weak medium and fine angular blocky; hard and firm; sticky and plastic; few very fine roots; many distinct clay films and organic coatings on faces of peds and in pores; about 1 percent gravel; neutral; clear wavy boundary.

Btn2—16 to 20 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard and firm; sticky and plastic; few very fine roots; common distinct clay films and few thin organic coatings on faces of peds; about 1 percent gravel; slightly alkaline; clear wavy boundary.

Bkyz—20 to 34 inches; light olive brown (2.5Y 5/4) clay loam, light gray (2.5Y 7/2) dry; weak medium prismatic structure parting to weak coarse subangular blocky; hard and firm; sticky and plastic; few very fine roots; about 2 percent gravel; common gypsum and other salt crystals; common irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Bky—34 to 47 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; few fine distinct light brownish gray (2.5Y 6/2) mottles; weak coarse subangular blocky structure; hard and friable; sticky and plastic; about 5 percent gravel; few fine nests of gypsum crystals; common irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—47 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 30 inches. The depth to gypsum and other salts ranges from 16 to 50 inches.

The Ap horizon has value of 2 or 3 (3 or 4 dry). Some pedons do not have an E horizon. The B/E horizon has value of 2 to 4 and chroma of 1 or 2. It is clay loam or silty clay loam. The Btn horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 to 3. It is clay loam or silty clay. The Bk horizon has value of 4 to 6 (5 to 7 dry). The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. It is loam or clay loam.

Divide Series

The Divide series consists of very deep, somewhat poorly drained, highly calcareous soils on terraces and outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Divide loam, 0 to 3 percent slopes, 2,550 feet north and 1,140 feet west of the southeast corner of sec. 7, T. 145 N., R. 57 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; common very fine and fine roots; about 1 percent gravel; about 3 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline; abrupt wavy boundary.

Bk1—9 to 22 inches; grayish brown (10YR 5/2) loam, white (10YR 8/2) dry; weak medium and fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine and fine roots; about 5 percent gravel; about 8 percent shale in the 0.1- to 76-millimeter fraction; few coatings of lime on the bottom of pebbles; violent effervescence; moderately alkaline; clear wavy boundary.

2Bk2—22 to 26 inches; grayish brown (2.5Y 5/2) gravelly sandy loam, light gray (2.5Y 7/2) dry; weak fine subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; about 15 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; violent effervescence; moderately alkaline; clear smooth boundary.

2C1—26 to 35 inches; grayish brown (2.5Y 5/2) very

gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; few medium faint light brownish gray (2.5Y 6/2) mottles; single grain; loose; nonsticky and nonplastic; about 40 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline; clear smooth boundary.

2C2—35 to 60 inches; grayish brown (2.5Y 5/2) sand, light gray (2.5Y 7/2) dry; single grain; loose; nonsticky and nonplastic; about 10 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has value of 3 to 6 (5 to 8 dry) and chroma of 1 to 4. Some pedons do not have a 2Bk horizon. The 2Bk and 2C horizons have more than 20 percent shale in the 0.1- to 76-millimeter fraction and have 5 to 50 percent gravel. The 2C horizon has hue of 2.5Y or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4.

Edgeley Series

The Edgeley series consists of moderately deep, well drained, moderately permeable soils in valleys and on till plains. These soils formed in colluvium, glacial till, and material weathered from shale bedrock. Slopes range from 0 to 35 percent.

Typical pedon of Edgeley silt loam, in an area of Edgeley-Kloten-Esmond complex, 9 to 35 percent slopes, 1,500 feet south and 980 feet east of the northwest corner of sec. 18, T. 146 N., R. 57 W.

A—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; slightly hard and friable; sticky and slightly plastic; many fine and very fine and few medium roots; neutral; clear wavy boundary.

Bw—8 to 20 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; sticky and slightly plastic; common fine and very fine and few medium roots; slightly alkaline; clear smooth boundary.

Bk—20 to 36 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard and firm; sticky and plastic; few very fine roots; about 10 percent shale channers; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

2Cr—36 to 60 inches; dark olive gray (5Y 3/2), weathered shale bedrock, light olive gray (5Y 6/2) dry.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to weathered shale bedrock ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 dry. It is silt loam or loam. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. It is loam, silt loam, or silty clay loam. Some pedons do not have a Bk horizon. Some have a C horizon. The 2Cr horizon has hue of 2.5Y or 5Y and value of 3 or 4.

Egeland Series

The Egeland series consists of very deep, well drained, moderately rapidly permeable soils on delta plains. These soils formed in glaciofluvial deposits. Slopes range from 1 to 6 percent.

Typical pedon of Egeland fine sandy loam, in an area of Embden-Egeland fine sandy loams, 1 to 6 percent slopes, 410 feet south and 1,920 feet west of the northeast corner of sec. 24, T. 144 N., R. 54 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; clear smooth boundary.

Bw—8 to 16 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium prismatic structure parting to weak fine subangular blocky; soft and very friable; slightly sticky and nonplastic; common very fine roots; neutral; clear smooth boundary.

Bk—16 to 29 inches; light olive brown (2.5Y 5/4) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; soft and very friable; slightly sticky and nonplastic; few very fine roots; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—29 to 37 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft and very friable; nonsticky and nonplastic; few very fine roots; strong effervescence; slightly alkaline; clear smooth boundary.

C2—37 to 50 inches; light olive brown (2.5Y 5/4), stratified very fine sandy loam and silt loam, light yellowish brown (2.5Y 6/4) dry; massive; soft and very friable; nonsticky and nonplastic; strong effervescence; slightly alkaline; clear smooth boundary.

C3—50 to 60 inches; olive brown (2.5Y 4/4) loamy fine sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 8 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 5 (4 to 6 dry), and chroma of 2 to 4. The Bk horizon has value of 4 or 5 (5 to 7 dry). The C horizon has value of 5 to 7 dry.

Embden Series

The Embden series consists of very deep, moderately well drained and well drained, moderately rapidly permeable soils on delta plains and till plains. These soils formed in glaciofluvial deposits. Slopes range from 0 to 9 percent.

Typical pedon of Embden fine sandy loam, 1,750 feet north and 150 feet west of the southeast corner of sec. 23, T. 144 N., R. 54 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; neutral; clear smooth boundary.

Bw1—10 to 21 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; soft and very friable; slightly sticky and nonplastic; few very fine roots; neutral; clear smooth boundary.

Bw2—21 to 36 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few very fine roots; neutral; clear wavy boundary.

C1—36 to 46 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft and very friable; slightly sticky and nonplastic; slightly alkaline; clear smooth boundary.

C2—46 to 60 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 4. Some pedons have a Bk horizon. The C horizon has value of 4 to 6 (5 to 7 dry).

Emrick Series

The Emrick series consists of very deep, well drained, moderately permeable soils on till plains. These soils formed in glacial till. Slopes range from 0 to 6 percent.

Typical pedon of Emrick loam, in an area of Heimdal-Emrick loams, 3 to 6 percent slopes, 350 feet south and 2,210 feet east of the northwest corner of sec. 25, T. 144 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

Bw1—7 to 26 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; soft and very friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; neutral; clear smooth boundary.

Bw2—26 to 36 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft and very friable; slightly sticky and slightly plastic; few very fine roots; about 3 percent gravel; neutral; gradual wavy boundary.

Bk—36 to 48 inches; light yellowish brown (2.5Y 6/4) loam, pale yellow (2.5Y 8/4) dry; weak medium subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; about 4 percent gravel; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

BCk—48 to 52 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and very friable; slightly sticky and slightly plastic; about 4 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

C—52 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and very friable; slightly sticky and slightly plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bk horizon has value of 4 to 6 (5 to 8 dry) and chroma of 2 to 4. Some pedons do not have a BCk horizon. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4.

Esmond Series

The Esmond series consists of very deep, well drained, moderately permeable soils on till plains and in valleys. These soils formed in glacial till. Slopes range from 6 to 35 percent.

Typical pedon of Esmond loam, in an area of Heimdal-Esmond loams, 6 to 9 percent slopes, 200 feet west and 1,115 feet north of the southeast corner of sec. 25, T. 144 N., R. 54 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bk—7 to 26 inches; light yellowish brown (2.5Y 6/4) loam, pale yellow (2.5Y 7/4) dry; weak medium and fine subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; common medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—26 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard and very friable; slightly sticky and slightly plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The Ap horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4.

Fram Series

The Fram series consists of very deep, somewhat poorly drained, moderately permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slopes range from 0 to 3 percent.

Typical pedon of Fram loam, in an area of Fram-Wyard loams, 0 to 3 percent slopes, 75 feet west and 2,050 feet north of the southeast corner of sec. 15, T. 144 N., R. 55 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; very slight effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—7 to 21 inches; light yellowish brown (2.5Y 6/4) loam, white (2.5Y 8/2) dry; weak coarse and medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few very fine and fine roots; about 2 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—21 to 35 inches; light yellowish brown (2.5Y 6/4) loam, light gray (2.5Y 7/2) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; about 2 percent gravel; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—35 to 48 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few coarse prominent brownish yellow (10YR 6/8) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; common fine prominent dark gray (10YR 4/1) and few fine prominent dark yellowish brown (10YR 4/6) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; about 10 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. Some pedons have a Bky or BCk horizon. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4.

Gardena Series

The Gardena series consists of very deep, moderately well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes range from 0 to 3 percent.

Typical pedon of Gardena loam, 0 to 3 percent slopes, 925 feet south and 2,530 feet east of the northwest corner of sec. 9, T. 148 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; clear smooth boundary.

A—7 to 17 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots;

many very fine pores; slightly alkaline; gradual wavy boundary.

Bw1—17 to 21 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; many very fine pores; slightly alkaline; clear smooth boundary.

Bw2—21 to 31 inches; dark brown (10YR 4/3) very fine sandy loam, brown (10YR 5/3) dry; weak medium and coarse subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few very fine pores; slightly alkaline; clear smooth boundary.

Bk—31 to 43 inches; light olive brown (2.5Y 5/4) silt loam, light gray (2.5Y 7/2) dry; slightly hard and friable; slightly sticky and slightly plastic; few very fine pores; few fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—43 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; slightly hard and very friable; slightly sticky and nonplastic; few fine pores; common thin accumulations of iron and manganese oxide along old root channels; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The Bw horizon has hue of 10YR or 2.5Y. It is loam, very fine sandy loam, or silt loam. The Bk horizon has value of 4 to 6 (5 to 7 dry). The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. It typically is silt loam or very fine sandy loam, but in some pedons it is silty clay loam below a depth of 40 inches.

Gilby Series

The Gilby series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits and glacial till. Slopes are 0 to 1 percent.

Typical pedon of Gilby loam, 220 feet west and 1,425 feet south of the northeast corner of sec. 3, T. 145 N., R. 54 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—9 to 15 inches; grayish brown (10YR 5/2) loam, light gray (10YR 7/1) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard and very friable; slightly sticky and slightly plastic; common very fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—15 to 21 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; weak medium and fine subangular blocky structure; slightly hard and very friable; slightly sticky and slightly plastic; few very fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

2Bky—21 to 25 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse and medium subangular blocky structure; slightly hard and friable; sticky and slightly plastic; about 5 percent gravel; many large nests of gypsum crystals; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

2By—25 to 47 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; massive; hard and firm; sticky and plastic; about 3 percent gravel; few large nests of gypsum crystals; strong effervescence; moderately alkaline; gradual wavy boundary.

2C—47 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; many medium grayish brown (10YR 5/2), common fine yellowish brown (10YR 5/6), and few fine strong brown (7.5YR 4/6) prominent mottles; massive; hard and firm; sticky and plastic; about 3 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. Depth to the 2B horizon ranges from 20 to 40 inches.

The Ap horizon has value of 3 or 4 dry. The Bk horizon has value of 6 or 7 dry and chroma of 1 to 3. It is loam, very fine sandy loam, or silt loam. The 2By horizon has value of 4 to 6 (6 or 7 dry). Some pedons have a 2Bk horizon. Some have a C horizon. The 2C horizon has value of 4 to 6 (6 or 7 dry) and chroma of 2 to 4. It is loam or clay loam.

Glyndon Series

The Glyndon series consists of very deep, somewhat poorly drained, moderately permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes are 0 to 1 percent.

Typical pedon of Glyndon loam, in an area of Glyndon-Tiffany loams, 150 feet north and 600 feet

west of the southeast corner of sec. 2, T. 148 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine and fine roots; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bky1—7 to 25 inches; grayish brown (10YR 5/2) loam, white (10YR 8/2) dry; weak medium subangular blocky structure; slightly hard and very friable; slightly sticky and nonplastic; few very fine and fine roots; common medium nests of gypsum crystals; violent effervescence; moderately alkaline; clear wavy boundary.

Bky2—25 to 30 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few fine roots; common fine pores; few medium nests of gypsum crystals; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—30 to 53 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; few fine prominent light brownish gray (10YR 6/2) mottles; massive; soft and friable; slightly sticky and slightly plastic; common thin accumulations of iron and manganese oxide along old root channels; slight effervescence; moderately alkaline; clear smooth boundary.

C2—53 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam, pale yellow (2.5Y 7/4) dry; many medium and fine prominent light brownish gray (10YR 6/2) mottles; massive; soft and very friable; slightly sticky and nonplastic; common thin accumulations of iron and manganese oxide along old root channels; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The Ap horizon has value of 2 or 3 (3 or 4 dry). Some pedons have an ABk horizon. The Bky horizon has value of 4 or 5 (5 to 8 dry) and chroma of 1 to 4. The C horizon has value of 4 to 6 (5 to 7 dry). It is dominantly silt loam or very fine sandy loam, but in some pedons it is silty clay loam below a depth of 40 inches.

Hamerly Series

The Hamerly series consists of very deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slopes range from 0 to 6 percent.

Typical pedon of Hamerly loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes, 580 feet north and 600 feet east of the southwest corner of sec. 29, T. 144 N., R. 57 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; soft and friable; sticky and plastic; few very fine roots; about 2 percent gravel; slight effervescence; moderately alkaline; abrupt wavy boundary.

Bk1—9 to 20 inches; light brownish gray (2.5Y 6/2) loam, white (2.5Y 8/2) dry; weak medium subangular blocky structure; slightly hard and friable; sticky and plastic; few very fine roots; about 2 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—20 to 37 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; slightly hard and firm; sticky and plastic; few very fine roots; about 5 percent gravel; common medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—37 to 60 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; common fine prominent dark yellowish brown (10YR 4/6) and few fine prominent olive gray (5Y 5/2) mottles; massive; slightly hard and firm; sticky and plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 14 inches. In some pedons the soils are saline.

The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 6 to 8 dry, and chroma of 1 to 4. It is loam or clay loam. Some pedons have a Bky or Bkyz horizon. The C horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. It is loam or clay loam.

Hecla Series

The Hecla series consists of very deep, moderately well drained, rapidly permeable soils on delta plains. These soils formed in glaciofluvial deposits. Slopes range from 0 to 3 percent.

Typical pedon of Hecla loamy fine sand, 1,955 feet south and 535 feet west of the northeast corner of sec. 1, T. 145 N., R. 54 W.

Ap—0 to 6 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; soft and very friable; nonsticky and nonplastic; common very fine roots; neutral; clear smooth boundary.

A1—6 to 13 inches; black (10YR 2/1) loamy fine sand,

very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; loose; nonsticky and nonplastic; few very fine roots; neutral; clear smooth boundary.

A2—13 to 24 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; loose; nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

AC—24 to 31 inches; very dark grayish brown (10YR 3/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose; nonsticky and nonplastic; neutral; clear smooth boundary.

C1—31 to 36 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark brown (10YR 4/3) mottles; single grain; loose; nonsticky and nonplastic; about 1 percent gravel; slightly alkaline; clear smooth boundary.

C2—36 to 60 inches; olive brown (2.5Y 4/4) fine sand, pale yellow (2.5Y 7/4) dry; common fine and medium distinct grayish brown (2.5Y 5/2) and prominent dark yellowish brown (10YR 4/6) mottles; single grain; loose; nonsticky and nonplastic; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The AC horizon has value of 2 or 3 (3 to 5 dry). It is loamy fine sand or fine sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 2 to 4.

Heimdal Series

The Heimdal series consists of very deep, well drained, moderately permeable soils on till plains. These soils formed in glacial till. Slopes range from 0 to 15 percent.

Typical pedon of Heimdal loam, in an area of Heimdal-Emrick loams, 3 to 6 percent slopes, 170 feet south and 2,070 feet east of the northwest corner of sec. 25, T. 144 N., R. 54 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

Bw1—6 to 10 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

Bw2—10 to 19 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; soft and friable; slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; slightly alkaline; clear wavy boundary.

Bk1—19 to 25 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; about 3 percent gravel; common medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2—25 to 37 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak coarse and medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; few fine irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—37 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; massive; soft and friable; slightly sticky and slightly plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. The Bk horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4. Some pedons have a BCk horizon. The C horizon has value of 4 to 6 (6 or 7 dry) and chroma of 2 to 4.

Kloten Series

The Kloten series consists of shallow, well drained, moderately permeable soils in valleys. These soils formed in material weathered from shale bedrock. Slopes range from 9 to 35 percent.

Typical pedon of Kloten silt loam, in an area of Edgeley-Kloten-Esmond complex, 9 to 35 percent slopes, 1,800 feet south and 850 feet east of the northwest corner of sec. 18, T. 146 N., R. 57 W.

A—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine and medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; many very fine and few medium roots; about 5 percent shale channers; slight effervescence; slightly alkaline; abrupt wavy boundary.

Cr—7 to 60 inches; dark olive gray (5Y 3/2), weathered shale bedrock, light olive gray (5Y 6/2) dry.

The thickness of the mollic epipedon ranges from 7

to 10 inches. The depth to weathered shale bedrock ranges from 7 to 20 inches. The A horizon has value of 2 or 3 (4 or 5 dry). Some pedons have a C horizon.

Kratka Series

The Kratka series consists of very deep, poorly drained soils on delta plains. These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Kratka fine sandy loam, 2,310 feet west and 1,850 feet north of the southeast corner of sec. 20, T. 146 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; few very fine roots; neutral; clear smooth boundary.

A—8 to 13 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few very fine roots; neutral; clear wavy boundary.

C1—13 to 21 inches; light brownish gray (2.5Y 6/2) loamy fine sand, light gray (2.5Y 7/2) dry; few fine prominent black (5YR 2.5/1) and common fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; nonsticky and nonplastic; about 1 percent fine gravel; neutral; clear wavy boundary.

C2—21 to 30 inches; light brownish gray (2.5Y 6/2) loamy fine sand, light gray (2.5Y 7/2) dry; many fine and medium prominent dark brown (7.5YR 3/2) and common fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; nonsticky and nonplastic; neutral; abrupt smooth boundary.

2C3—30 to 38 inches; gray (5Y 6/1) silty clay loam, light gray (5Y 7/1) dry; few medium prominent dark yellowish brown (10YR 4/6) mottles; massive; slightly hard and firm; sticky and plastic; few fine and medium irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

2C4—38 to 60 inches; gray (5Y 6/1) silty clay loam, light gray (5Y 7/1) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard and firm; sticky and plastic; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 8 to 18 inches. The depth to silty clay loam or silt loam ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). Some pedons have a Bw horizon. The C horizon has value of 4 to 6 and chroma of 2 to 4. It is loamy fine sand, loamy sand, fine sand, or sand. The 2C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 3. It is silty clay loam or silt loam.

LaDelle Series

The LaDelle series consists of very deep, moderately well drained, moderately permeable or moderately slowly permeable soils on flood plains. These soils formed in alluvium. Slopes range from 0 to 3 percent.

Typical pedon of LaDelle silt loam, 0 to 3 percent slopes, 2,010 feet west and 1,630 feet south of the northeast corner of sec. 28, T. 148 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; neutral; clear smooth boundary.

A—7 to 20 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine granular; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; gradual wavy boundary.

Bw1—20 to 27 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; clear wavy boundary.

Bw2—27 to 36 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; slightly alkaline; abrupt smooth boundary.

Ab—36 to 38 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard and firm; sticky and slightly plastic; few irregularly shaped masses of lime; slight effervescence; slightly alkaline; abrupt smooth boundary.

C—38 to 60 inches; olive brown (2.5Y 4/4) silt loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard and friable; slightly sticky and slightly plastic; few fine threads of lime; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 17 to 50 inches. The A, Bw, and C horizons are silt loam or silty clay loam. The A horizon has value of 2 or 3. The Bw horizon has value of 3 or 4 (4 to 6 dry). The C

horizon has value of 3 to 5 (5 to 7 dry) and chroma of 2 to 4.

Lamoure Series

The Lamoure series consists of very deep, poorly drained, moderately permeable, calcareous soils on till plains. These soils formed in alluvium. Slopes are 0 to 1 percent.

Typical pedon of Lamoure silt loam, in an area of Lamoure and Rauville silt loams, 25 feet west and 500 feet south of the northeast corner of sec. 1, T. 148 N., R. 55 W.

A1—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine and fine and few medium roots; slight effervescence; moderately alkaline; clear smooth boundary.

A2—9 to 30 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine and fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—30 to 51 inches; dark gray (5Y 4/1) silt loam, gray (5Y 5/1) dry; few fine prominent olive brown (2.5Y 4/4) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; few fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—51 to 60 inches; olive gray (5Y 4/2) silt loam, light gray (5Y 6/1) dry; common fine prominent olive brown (2.5Y 4/4) mottles; massive; slightly hard and friable; sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 50 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Cg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 to 6 (5 to 8 dry) and chroma of 0 to 2. It is silt loam or silty clay loam.

Lankin Series

The Lankin series consists of very deep, moderately well drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits and glacial till. Slopes are 0 to 1 percent.

Typical pedon of Lankin loam, 220 feet east and 2,350 feet south of the northwest corner of sec. 30, T. 146 N., R. 54 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine and few medium roots; neutral; abrupt smooth boundary.

A—6 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate fine granular; slightly hard and friable; slightly sticky and slightly plastic; many very fine and few fine roots; neutral; clear wavy boundary.

Bw1—10 to 14 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; common very fine and fine roots; slightly alkaline; clear wavy boundary.

Bw2—14 to 18 inches; very dark grayish brown (2.5Y 3/2) loam, dark grayish brown (2.5Y 4/2) dry; moderate medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; clear wavy boundary.

Bk1—18 to 25 inches; light yellowish brown (2.5Y 6/3) loam, white (2.5Y 8/2) dry; moderate medium and fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; common irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

2Bk2—25 to 32 inches; light yellowish brown (2.5Y 6/3) clay loam, light gray (2.5Y 7/2) dry; massive; slightly hard and firm; sticky and plastic; about 3 percent gravel; common irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

2C1—32 to 43 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; slightly hard and friable; slightly sticky and plastic; about 5 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—43 to 60 inches; light olive brown (2.5Y 5/3) clay loam, light yellowish brown (2.5Y 6/3) dry; common medium gray (10YR 6/1) and many medium yellowish brown (10YR 5/6) prominent mottles; massive; slightly hard and firm; sticky and plastic; about 8 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 25 inches. Depth to the 2Bk2 horizon ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 dry. The Bw horizon has value 2 to 4 (3 to 5 dry) and chroma of 1 or

2. The Bk and 2Bk horizons have value of 5 or 6 and chroma of 2 to 4. The 2Bk horizon is loam or clay loam. The 2C horizon has value of 4 to 6 (6 or 7 dry) and chroma of 2 to 4.

Maddock Series

The Maddock series consists of very deep, well drained, rapidly permeable soils on delta plains and till plains. These soils formed in glaciofluvial deposits. Slopes range from 1 to 15 percent.

Typical pedon of Maddock loamy fine sand, in an area of Maddock-Hecla loamy fine sands, 1 to 6 percent slopes, 550 feet east and 1,040 feet north of the southwest corner of sec. 25, T. 146 N., R. 54 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; loose; nonsticky and nonplastic; common very fine roots; neutral; clear smooth boundary.

Bw—11 to 29 inches; dark brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; single grain; loose; nonsticky and nonplastic; few very fine roots; neutral; clear wavy boundary.

C—29 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; single grain; loose; nonsticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 or 4 (5 or 6 dry) and chroma of 2 or 3. It is fine sand or loamy fine sand. Some pedons do not have a Bw horizon. The C horizon has value of 4 or 5 (6 or 7 dry) and chroma of 2 to 4. It is fine sand or loamy fine sand.

Marysland Series

The Marysland series consists of very deep, poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Marysland loam, 1,050 feet east and 240 feet north of the southwest corner of sec. 6, T. 147 N., R. 57 W.

Ap—0 to 9 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak medium subangular blocky structure; slightly hard and friable; sticky and plastic; few very fine and medium roots; violent effervescence; moderately alkaline; clear wavy boundary.

Bkg1—9 to 15 inches; gray (5Y 5/1) loam, light gray (5Y 7/1) dry; weak coarse and medium subangular blocky structure; slightly hard and firm; sticky and plastic; few very fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

Bkg2—15 to 21 inches; dark gray (5Y 4/1) loam, gray (5Y 6/1) dry; weak coarse and medium subangular blocky structure; slightly hard and firm; sticky and plastic; few very fine roots; about 2 percent gravel; about 3 percent shale in the 0.1- to 76-millimeter fraction; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg1—21 to 30 inches; olive gray (5Y 4/2) loam, light gray (5Y 7/2) dry; few fine dark yellowish brown (10YR 4/4) and common fine light olive brown (2.5Y 5/6) prominent mottles; massive; hard and firm; sticky and plastic; about 5 percent gravel; about 7 percent shale in the 0.1- to 76-millimeter fraction; few fine concretions of lime; slight effervescence; moderately alkaline; clear smooth boundary.

Cg2—30 to 35 inches; olive gray (5Y 5/2) loam, light gray (5Y 7/2) dry; common fine light olive brown (2.5Y 5/6) and few fine dark brown (10YR 4/3) prominent mottles; massive; hard and friable; slightly sticky and slightly plastic; about 10 percent gravel; about 8 percent shale in the 0.1- to 76-millimeter fraction; few fine irregularly shaped masses of lime; slight effervescence; moderately alkaline; clear wavy boundary.

2Cg3—35 to 48 inches; olive gray (5Y 5/2) gravelly loamy coarse sand, light gray (5Y 7/2) dry; single grain; loose; nonsticky and nonplastic; about 20 percent gravel; about 20 percent shale in the 0.1- to 76-millimeter fraction; very slight effervescence; moderately alkaline; clear wavy boundary.

2Cg4—48 to 60 inches; dark gray (5Y 4/1) gravelly loamy coarse sand, gray (5Y 6/1) dry; single grain; loose; nonsticky and nonplastic; about 30 percent gravel; about 25 percent shale in the 0.1- to 76-millimeter fraction; very slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 30 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The Ap horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. The Bkg horizon has hue of 10YR to 5Y, value of 3 to 6 (4 to 7 dry), and chroma of 1 or 2. The Cg horizon has hue of 5Y or 2.5Y and chroma of 1 or 2. Some pedons do not have a Cg horizon. The 2Cg horizon has hue of 5Y or 2.5Y and value of 3 to 6 (4 to 7 dry). It has more than 20 percent shale in the 0.1- to 76-millimeter fraction and has 5 to 40 percent gravel.

Miranda Series

The Miranda series consists of very deep, somewhat poorly drained, very slowly permeable, sodic-saline soils on till plains. These soils formed in glacial till. Slopes range from 0 to 3 percent.

Typical pedon of Miranda loam, 0 to 3 percent slopes, 1,475 feet south and 1,300 feet east of the northwest corner of sec. 6, T. 145 N., R. 57 W.

Ap—0 to 4 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

E—4 to 5 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure parting to weak medium and thin platy; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Btn—5 to 11 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and coarse columnar structure parting to moderate fine angular blocky; hard and firm; sticky and plastic; common very fine roots on faces of peds; dark gray (10YR 4/1) coatings of silt and sand on the top of columns; many moderately thick clay films and organic coatings on faces of peds and in pores; moderately alkaline; clear wavy boundary.

Btknyz—11 to 16 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to weak medium and fine angular and subangular blocky; hard and firm; sticky and plastic; few very fine roots; few thin clay films on faces of peds; about 2 percent gravel; many very fine threads of salt; common nests of gypsum crystals; common irregularly shaped masses of lime; strong effervescence; strongly alkaline; clear smooth boundary.

Bky1—16 to 26 inches; light olive brown (2.5Y 5/3) loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to weak fine subangular blocky; hard and firm; sticky and plastic; few very fine roots; about 2 percent gravel; common nests of gypsum crystals; few irregularly shaped masses of lime; strong effervescence; strongly alkaline; gradual wavy boundary.

Bky2—26 to 42 inches; light olive brown (2.5Y 5/3) loam, pale yellow (2.5Y 7/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and common fine prominent dark gray (10YR 4/1) mottles; weak medium subangular blocky structure; hard and friable; sticky and plastic; about 2 percent gravel; few nests of gypsum crystals; few irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—42 to 60 inches; olive brown (2.5Y 4/3) loam, light yellowish brown (2.5Y 6/3) dry; common fine prominent gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; massive; hard and firm; sticky and plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The depth to horizons that have accumulations of gypsum and other salts ranges from 5 to 16 inches.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The E horizon has value of 3 or 4 (4 to 7 dry) and chroma of 1 or 2. Some pedons do not have an E horizon. The Btn horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. The Bky and C horizons are loam or clay loam. The Bky horizon has value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. The C horizon has value of 4 or 5 (5 to 8 dry) and chroma of 2 to 4.

Overly Series

The Overly series consists of very deep, moderately well drained and well drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes range from 0 to 15 percent.

Typical pedon of Overly silt loam, in an area of Zell-Overly silt loams, 6 to 9 percent slopes, 1,550 feet west and 950 feet north of the southeast corner of sec. 27, T. 147 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine and fine roots; slightly alkaline; clear smooth boundary.

A—7 to 14 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; slightly hard and friable; slightly sticky and slightly plastic; common very fine roots; slightly alkaline; clear wavy boundary.

Bw—14 to 20 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard and firm; sticky and plastic; few very fine roots; slightly alkaline; clear smooth boundary.

Bk—20 to 31 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; weak medium

prismatic structure parting to weak medium and fine subangular blocky; slightly hard and friable; slightly sticky and plastic; violent effervescence; moderately alkaline; clear smooth boundary.

C1—31 to 39 inches; light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) silty clay loam, pale yellow (2.5Y 7/4) and light gray (2.5Y 7/2) dry; massive; slightly hard and firm; sticky and plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

C2—39 to 44 inches; light yellowish brown (2.5Y 6/4) silt loam, pale yellow (2.5Y 7/4) dry; few fine distinct grayish brown (2.5Y 5/2) relict mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

C3—44 to 60 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) silty clay loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; few fine prominent yellowish brown (10YR 5/6) relict mottles; massive; hard and firm; sticky and plastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A, Bw, and Bk horizons are silt loam or silty clay loam. The A horizon has value of 3 or 4 dry. The Bw horizon has hue of 2.5Y or 10YR, value of 2 to 4 (3 to 5 dry), and chroma of 2 to 4. The Bk horizon has value of 3 to 5 (5 to 7 dry) and chroma of 2 to 4. The C horizon has value of 4 to 6 (5 to 7 dry).

Parnell Series

The Parnell series consists of very deep, very poorly drained, slowly permeable soils on till plains. These soils formed in alluvium. Slopes are 0 to 1 percent.

Typical pedon of Parnell silty clay loam, in an area of Vallers-Parnell complex, 180 feet north and 2,500 feet east of the southwest corner of sec. 4, T. 147 N., R. 57 W.

A1—0 to 6 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate coarse and medium subangular blocky structure; slightly hard and friable; sticky and plastic; many very fine, common medium, and few coarse roots; neutral; clear smooth boundary.

A2—6 to 12 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak medium subangular blocky structure; slightly hard and friable; sticky and plastic; common very fine roots; neutral; clear wavy boundary.

Btg1—12 to 30 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; weak medium prismatic structure parting to moderate fine and medium angular blocky; hard and firm; very sticky and very plastic; few very fine roots; many thick clay films on faces of peds and in pores; neutral; gradual wavy boundary.

Btg2—30 to 38 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; common fine distinct dark grayish brown (2.5Y 4/2) mottles; weak medium prismatic structure parting to moderate fine angular blocky; very hard and firm; very sticky and very plastic; common moderately thick clay films on faces of peds and in pores; neutral; gradual wavy boundary.

Btg3—38 to 50 inches; dark olive gray (5Y 3/2) silty clay, olive gray (5Y 5/2) dry; many fine olive (5Y 4/4) and common fine light olive gray (5Y 6/2) distinct mottles; weak coarse subangular blocky structure; very hard and firm; very sticky and very plastic; common thin clay films on faces of peds; slightly alkaline; diffuse wavy boundary.

Cg—50 to 60 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; many fine and medium prominent olive brown (2.5Y 4/4) mottles; massive; very hard and firm; very sticky and very plastic; slightly alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Btg horizon has value of 2 to 4 (3 to 5 dry). It is silty clay or silty clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 or 2. It is silty clay loam, silty clay, or clay loam.

Perella Series

The Perella series consists of very deep, somewhat poorly drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes are 0 to 1 percent.

Typical pedon of Perella silty clay loam, in an area of Bearden-Perella silty clay loams, 465 feet west and 2,300 feet north of the southeast corner of sec. 30, T. 147 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular and angular blocky structure; slightly hard and firm; sticky and plastic; many very fine roots; common very fine pores; neutral; abrupt smooth boundary.

A—7 to 13 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium platy

and moderate fine angular and subangular blocky structure; slightly hard and firm; sticky and plastic; many very fine roots; many very fine pores; neutral; clear wavy boundary.

Bw—13 to 22 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; common fine prominent dark olive brown (2.5Y 3/3) mottles; moderate medium prismatic structure parting to moderate fine angular blocky; slightly hard and firm; sticky and plastic; common very fine roots; many very fine pores; slightly alkaline; clear smooth boundary.

Bk1—22 to 31 inches; olive (5Y 5/3) silty clay loam, light gray (5Y 7/2) dry; common fine distinct grayish brown (2.5Y 5/2) mottles; weak medium and fine subangular blocky structure; slightly hard and friable; sticky and plastic; few very fine roots; common very fine pores; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—31 to 42 inches; light yellowish brown (2.5Y 6/3) silty clay loam, pale yellow (2.5Y 7/3) dry; many fine prominent gray (10YR 6/1) and few fine distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; slightly hard and friable; sticky and plastic; common very fine pores; few irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—42 to 53 inches; light olive brown (2.5Y 5/3), stratified silty clay loam and silt loam, pale yellow (2.5Y 7/3) dry; common fine dark yellowish brown (10YR 4/6) and many fine gray (10YR 6/1) prominent mottles; massive; slightly hard and firm; sticky and plastic; few very fine pores; common nests of gypsum crystals; strong effervescence; moderately alkaline; clear wavy boundary.

C2—53 to 60 inches; light olive brown (2.5Y 5/3), stratified silty clay loam and silt loam, pale yellow (2.5Y 7/3) dry; many medium prominent yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; massive; hard and firm; sticky and plastic; few very fine pores; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Bw and Bk horizons are silty clay loam or silt loam. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 1 or 2. The Bk horizon has value of 3 to 6 (5 to 7 dry). The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 2 to 4.

Rauville Series

The Rauville series consists of very deep, very poorly drained, moderately permeable, calcareous soils on till plains. These soils formed in alluvium. Slopes are 0 to 1 percent.

Typical pedon of Rauville silt loam, in an area of Lamoure and Rauville silt loams, 1,310 feet east and 350 feet north of the southwest corner of sec. 24, T. 144 N., R. 55 W.

Oa—5 inches to 0; black (10YR 2/1) muck, very dark gray (10YR 3/1) dry; weak fine granular structure; soft and very friable; nonsticky and nonplastic; many very fine and fine, common medium, and few coarse roots; few fine snail shell fragments; slight effervescence; moderately alkaline; clear wavy boundary.

Ag1—0 to 20 inches; black (5Y 2.5/1) silt loam, dark gray (5Y 4/1) dry; weak medium and fine subangular blocky structure parting to weak fine granular; slightly hard and friable; slightly sticky and slightly plastic; common very fine and fine and few medium roots; few fine snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Ag2—20 to 29 inches; very dark gray (5Y 3/1) silt loam, gray (5Y 5/1) dry; hard and friable; sticky and slightly plastic; weak coarse subangular blocky structure; few fine snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg1—29 to 46 inches; dark gray (5Y 4/1) silty clay loam, gray (5Y 6/1) dry; massive; very hard and firm; sticky and plastic; few fine snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—46 to 60 inches; gray (5Y 5/1) clay loam, light gray (5Y 7/1) dry; massive; very hard and firm; sticky and plastic; few fine snail shell fragments; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. The thickness of the O horizon ranges from 1 to 6 inches. The Cg horizon has value of 3 to 5 (5 to 7 dry). It is silty clay loam, clay loam, or silt loam. Some pedons have a 2C horizon below a depth of 40 inches. This horizon is stratified sand to silt loam.

Southam Series

The Southam series consists of very deep, very poorly drained, slowly permeable, calcareous soils on till plains. These soils formed in alluvium. Slopes are 0 to 1 percent.

Typical pedon of Southam silty clay loam, 210 feet east and 950 feet south of the northwest corner of sec. 8, T. 148 N., R. 57 W.

Oa—4 inches to 0; black (N 2/0) muck, dark gray (N 4/0) dry; weak fine and medium subangular blocky structure; soft and very friable; nonsticky and nonplastic; many very fine and few medium and coarse roots; about 1 percent snail shell fragments; slight effervescence; slightly alkaline; clear smooth boundary.

Ag1—0 to 16 inches; black (5Y 2.5/1) silty clay loam, dark gray (5Y 4/1) dry; weak medium subangular blocky structure; hard and firm; sticky and very plastic; few fine and medium roots; about 2 percent snail shell fragments; slight effervescence; slightly alkaline; gradual wavy boundary.

Ag2—16 to 28 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; common fine prominent olive brown (2.5Y 4/4) mottles; weak coarse and medium subangular blocky structure; hard and very firm; very sticky and very plastic; about 5 percent snail shell fragments; slight effervescence; moderately alkaline; gradual smooth boundary.

Ag3—28 to 60 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; common medium prominent olive brown (2.5Y 4/4) mottles; massive; very hard and very firm; very sticky and very plastic; about 5 percent snail shell fragments; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. The thickness of the O horizon ranges from 1 to 6 inches. The Ag horizon has hue of 5Y to 10YR or is neutral in hue. It has value of 3 to 5 dry. Some pedons have a Cg horizon.

Svea Series

The Svea series consists of very deep, moderately well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slopes range from 0 to 9 percent.

Typical pedon of Svea loam, in an area of Svea-Buse loams, 3 to 6 percent slopes, 1,400 feet west and 1,100 feet south of the northeast corner of sec. 8, T. 148 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and friable; slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bw1—8 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium and fine subangular blocky; soft and friable; slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

Bw2—17 to 23 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard and friable; sticky and slightly plastic; few very fine roots; about 2 percent gravel; slightly alkaline; clear wavy boundary.

Bk—23 to 36 inches; pale brown (10YR 6/3) loam, very pale brown (10YR 7/3) dry; weak coarse subangular blocky structure; slightly hard and firm; sticky and plastic; few very fine roots; about 5 percent gravel; few fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C—36 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct grayish brown (2.5Y 5/2) and common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; slightly hard and firm; sticky and plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 34 inches. The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 2 to 4. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is loam or clay loam. Some pedons have a BCk horizon. The C horizon has value of 4 or 5 (5 or 6 dry) and chroma of 2 to 4. It is loam or clay loam.

Swenoda Series

The Swenoda series consists of very deep, moderately well drained soils on delta plains and till plains. These soils formed in glaciofluvial deposits and glacial till. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Swenoda fine sandy loam, 2,630 feet west and 1,570 feet south of the northeast corner of sec. 25, T. 147 N., R. 54 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common fine and medium roots; neutral; abrupt smooth boundary.

A—7 to 15 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium and

coarse subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common fine and few medium roots; neutral; gradual wavy boundary.

Bw1—15 to 26 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; soft and very friable; slightly sticky and slightly plastic; few fine roots; neutral; clear wavy boundary.

Bw2—26 to 30 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent dark yellowish brown (10YR 4/6) mottles; weak coarse subangular blocky structure; soft and loose; slightly sticky and nonplastic; slightly alkaline; abrupt smooth boundary.

2Bw3—30 to 35 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; common fine distinct olive brown (2.5Y 4/4) mottles; moderate coarse subangular blocky structure; slightly hard and firm; slightly sticky and slightly plastic; slightly alkaline; gradual wavy boundary.

2Bk1—35 to 45 inches; light brownish gray (2.5Y 6/2) silt loam, white (2.5Y 8/2) dry; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; hard and firm; sticky and plastic; many medium irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

2Bk2—45 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; many medium gray (10YR 5/1) and few fine light olive brown (2.5Y 5/4) distinct mottles; massive; hard and firm; sticky and plastic; common medium irregularly shaped masses of lime; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. Depth to the 2Bw or 2Bk horizon ranges from 20 to 40 inches. The Bw horizon has value of 4 to 6 dry. Some pedons do not have a 2Bw horizon. The 2Bk horizon has value of 4 to 6 (6 to 8 dry) and chroma of 2 to 4. It is silty clay loam, silt loam, or loam. Some pedons have a 2C horizon.

Tiffany Series

The Tiffany series consists of very deep, poorly drained and somewhat poorly drained soils on delta plains and lake plains. These soils formed in glaciofluvial deposits and glaciolacustrine deposits. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Tiffany loam, in an area of Wyndmere-Tiffany complex, silty substratum, 1,740 feet north and 630 feet west of the southeast corner of sec. 30, T. 148 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; slightly hard and friable; slightly sticky and slightly plastic; many very fine roots; neutral; clear smooth boundary.

A—8 to 22 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; common fine distinct dark brown (10YR 4/3) mottles; weak medium prismatic structure parting to weak medium and coarse subangular blocky; slightly hard and friable; slightly sticky and slightly plastic; few very fine roots; neutral; clear wavy boundary.

C1—22 to 35 inches; olive gray (5Y 5/2) fine sandy loam, light gray (5Y 7/2) dry; few fine strong brown (7.5YR 4/6) and common fine black (5YR 2.5/1) prominent mottles; massive; soft and very friable; slightly sticky and nonplastic; few very fine roots in the upper part; neutral; clear smooth boundary.

C2—35 to 39 inches; olive gray (5Y 5/2) loamy fine sand, light gray (5Y 7/2) dry; common fine yellowish brown (10YR 5/4) and few fine black (5YR 2.5/1) prominent mottles; massive; loose; nonsticky and nonplastic; neutral; clear smooth boundary.

C3—39 to 45 inches; olive gray (5Y 5/2) fine sandy loam, light gray (5Y 7/2) dry; common medium dark yellowish brown (10YR 4/4) and few fine dark brown (7.5YR 3/2) prominent mottles; massive; soft and very friable; slightly sticky and nonplastic; neutral; abrupt smooth boundary.

2C4—45 to 54 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; many fine dark yellowish brown (10YR 4/4), common fine dark brown (7.5YR 4/4), and few fine black (5YR 2.5/1) prominent mottles; massive; slightly hard and firm; sticky and plastic; neutral; clear wavy boundary.

2C5—54 to 60 inches; olive gray (5Y 5/2), stratified silty clay loam and silt loam, light gray (5Y 7/2) dry; common medium prominent strong brown (7.5YR 4/6) mottles; massive; slightly hard and friable; sticky and plastic; few fine nests of gypsum crystals along seams in laminations; strong effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The A horizon has value of 3 to 5 dry. Some pedons have a Bw, Bk, or AC horizon, which is loam, silt loam, or very fine sandy loam. The C horizon has hue of 5Y or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. The 2C horizon has value of 4 to 6 (5 to 7 dry). Some pedons do not have a 2C horizon.

Tonka Series

The Tonka series consists of very deep, poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slopes are 0 to 1 percent.

Typical pedon of Tonka silt loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes, 410 feet north and 575 feet east of the southwest corner of sec. 29, T. 144 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium and fine granular structure; soft and very friable; slightly sticky and slightly plastic; common medium and fine and few very fine roots; slightly acid; gradual wavy boundary.

E1—7 to 12 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; many fine distinct dark brown (10YR 3/3) mottles; weak medium subangular blocky structure parting to weak thin platy; soft and very friable; slightly sticky and slightly plastic; few very fine roots; common very fine and fine pores; slightly acid; clear wavy boundary.

E2—12 to 21 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 7/1) dry; many medium and fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to moderate thin platy; soft and very friable; slightly sticky and slightly plastic; few very fine, medium, and coarse roots; many very fine pores; slightly acid; clear smooth boundary.

Btg1—21 to 26 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; few fine prominent olive brown (2.5Y 4/4) mottles; strong medium prismatic structure parting to moderate medium and fine angular blocky; hard and firm; sticky and plastic; few very fine and coarse roots; common moderately thick clay films on faces of peds; bleached silt grains along faces of peds; slightly acid; gradual smooth boundary.

Btg2—26 to 48 inches; black (5Y 2/1) silty clay, dark gray (5Y 4/1) dry; strong medium prismatic structure parting to strong fine angular blocky; hard and firm; very sticky and very plastic; few very fine and coarse roots; many thick clay films on faces of peds and in pores; slightly acid; gradual wavy boundary.

2BCg—48 to 58 inches; olive gray (5Y 4/2) clay loam, light olive gray (5Y 6/2) dry; many coarse prominent dark yellowish brown (10YR 4/6) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; hard and firm; very sticky and very plastic; few thin clay films on faces of peds in the upper part; about 5 percent gravel; neutral; gradual irregular boundary.

2Cg—58 to 60 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; hard and firm; sticky and plastic; about 5 percent gravel; very slight effervescence; slightly alkaline.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The E horizon has hue of 2.5Y or 10YR, value of 3 to 5, and chroma of 1 or 2. It is silt loam or loam. The Btg horizon has hue of 10YR to 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or 2. It is silty clay loam, silty clay, or clay loam. Some pedons do not have a 2BCg horizon. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. It is clay loam or loam. Some pedons have a Cg horizon, which is silty clay loam.

Vallers Series

The Vallers series consists of very deep, poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slopes are 0 to 1 percent.

Typical pedon of Vallers loam, in an area of Vallers-Parnell complex, 650 feet east and 210 feet south of the northwest corner of sec. 33, T. 148 N., R. 57 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard and friable; sticky and plastic; common very fine roots; violent effervescence; moderately alkaline; abrupt smooth boundary.

ABk—9 to 13 inches; very dark gray (10YR 3/1) loam, gray (10YR 6/1) dry; weak coarse and medium subangular blocky structure; slightly hard and firm; sticky and plastic; common very fine roots; about 2 percent gravel; violent effervescence; moderately alkaline; clear smooth boundary.

Bkg1—13 to 20 inches; dark gray (5Y 4/1) loam, light gray (5Y 7/1) dry; weak medium and fine subangular blocky structure; slightly hard and friable; sticky and plastic; about 2 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

Bkg2—20 to 26 inches; olive gray (5Y 4/2) loam, light olive gray (5Y 6/2) dry; weak medium and fine subangular blocky structure; slightly hard and friable; sticky and plastic; about 2 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

Bkg3—26 to 32 inches; olive gray (5Y 5/2) loam, light olive gray (5Y 6/2) dry; common medium prominent olive brown (2.5Y 4/4) mottles; massive; slightly

hard and friable; sticky and plastic; about 5 percent gravel; common medium irregularly shaped masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg—32 to 60 inches; olive gray (5Y 5/2) loam, light gray (5Y 7/2) dry; few coarse and common fine and medium prominent dark yellowish brown (10YR 4/4) mottles; massive; hard and firm; sticky and plastic; about 5 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. In some pedons the soils are saline.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (3 to 5 dry). Some pedons do not have an ABk horizon. The Bkg horizon has hue of 10YR to 5Y and value of 3 to 6 (5 to 8 dry). It is loam or clay loam. Some pedons have a BCkg horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. It is loam or clay loam.

Velva Series

The Velva series consists of very deep, well drained, moderately rapidly permeable soils on flood plains and terraces. These soils formed in alluvium. Slopes range from 0 to 6 percent.

Typical pedon of Velva fine sandy loam, 0 to 6 percent slopes, 1,775 feet west and 1,900 feet north of the southeast corner of sec. 6, T. 146 N., R. 54 W.

A—0 to 6 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; soft and friable; slightly sticky and slightly plastic; many very fine and few medium roots; very slight effervescence; neutral; gradual wavy boundary.

AC—6 to 12 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; soft and very friable; slightly sticky and nonplastic; many very fine and fine and few medium roots; very slight effervescence; neutral; gradual wavy boundary.

C1—12 to 17 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grain; loose; nonsticky and nonplastic; common fine and few coarse roots; very slight effervescence; neutral; abrupt wavy boundary.

C2—17 to 25 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium and fine subangular blocky structure; soft and very friable; slightly sticky and nonplastic; common fine and few coarse roots; slight effervescence; slightly alkaline; abrupt wavy boundary.

Ab—25 to 28 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak coarse and medium subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few fine and coarse roots; slight effervescence; slightly alkaline; clear wavy boundary.

C′—28 to 41 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few fine roots; slight effervescence; slightly alkaline; abrupt wavy boundary.

Ab′—41 to 46 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few fine roots; slight effervescence; slightly alkaline; gradual smooth boundary.

C″—46 to 60 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; massive; soft and very friable; slightly sticky and nonplastic; slight effervescence; slightly alkaline.

The thickness of the mollic epipedon ranges from 9 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The AC horizon has value of 3 or 4 (4 or 5 dry). It is fine sandy loam or loam. Some pedons do not have an AC horizon. Some have a Bw horizon. The C horizon has value of 3 to 5 (4 to 7 dry) and chroma of 2 to 4. It is fine sandy loam, loam, or loamy fine sand. Some pedons do not have an Ab horizon.

Walsh Series

The Walsh series consists of very deep, well drained, moderately slowly permeable soils in valleys. These soils formed in colluvium. Slopes range from 1 to 6 percent.

Typical pedon of Walsh silty clay loam, 1 to 6 percent slopes, 600 feet north and 100 feet east of the southwest corner of sec. 31, T. 147 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium and coarse subangular blocky structure; slightly hard and friable; sticky and plastic; common very fine roots; neutral; clear smooth boundary.

Bw1—8 to 28 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard and firm; sticky and plastic; common very fine

roots; neutral; gradual smooth boundary.
Bw2—28 to 38 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard and firm; sticky and plastic; about 2 percent shale channers; neutral; clear smooth boundary.
C—38 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; massive; hard and firm; sticky and plastic; about 5 percent shale channers; slightly alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The Ap horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (4 to 6 dry) and chroma of 1 or 2. The C horizon has value of 4 to 6 (5 to 7 dry). It is clay loam or silty clay loam.

Wyard Series

The Wyard series consists of very deep, somewhat poorly drained, moderately permeable soils on till plains. These soils formed in glacial till. Slopes are 0 to 1 percent.

Typical pedon of Wyard loam, in an area of Hamerly-Wyard loams, 0 to 3 percent slopes, 2,400 feet south and 670 feet east of the northwest corner of sec. 18, T. 144 N., R. 55 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; slightly hard and friable; sticky and plastic; common very fine roots; neutral; clear smooth boundary.
A—7 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; few fine distinct dark brown (10YR 4/3) mottles; weak medium subangular blocky structure; slightly hard and firm; sticky and plastic; common very fine roots; few uncoated sand grains on faces of peds; neutral; gradual wavy boundary.
Bw1—14 to 19 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; common fine prominent olive brown (2.5Y 4/4) mottles; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard and firm; sticky and plastic; few very fine roots; common uncoated sand grains on faces of peds; about 1 percent gravel; neutral; clear wavy boundary.
Bw2—19 to 26 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard and friable; sticky and plastic; about 2 percent gravel; neutral; clear wavy boundary.
Bk—26 to 36 inches; light brownish gray (2.5Y 6/2) loam, white (2.5Y 8/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard and friable; sticky and plastic; about 2 percent gravel; violent effervescence; moderately alkaline; gradual smooth boundary.
C—36 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; common fine prominent gray (10YR 6/1) and yellowish brown (10YR 5/6) mottles; massive; slightly hard and friable; slightly sticky and slightly plastic; about 5 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 24 inches. The Bw horizon has value of 4 to 6 dry and chroma of 1 to 4. The Bk horizon has value of 4 to 6 (5 to 8 dry) and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Wyndmere Series

The Wyndmere series consists of very deep, somewhat poorly drained, highly calcareous soils on delta plains. These soils formed in glaciofluvial deposits. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Wyndmere fine sandy loam, in an area of Wyndmere-Tiffany complex, silty substratum, 670 feet north and 990 feet east of the southwest corner of sec. 8, T. 146 N., R. 54 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; soft and friable; slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.
Bk1—8 to 15 inches; gray (10YR 5/1) fine sandy loam, light gray (10YR 7/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft and friable; slightly sticky and slightly plastic; few very fine roots; violent effervescence; moderately alkaline; clear wavy boundary.
Bk2—15 to 21 inches; brown (10YR 5/3) fine sandy loam, light gray (10YR 7/2) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few very fine roots; common irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

Bk3—21 to 29 inches; light yellowish brown (2.5Y 6/4) fine sandy loam, pale yellow (2.5Y 7/4) dry; weak coarse and medium subangular blocky structure; soft and very friable; slightly sticky and nonplastic; few irregularly shaped masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C1—29 to 33 inches; light yellowish brown (2.5Y 6/4) loamy fine sand, pale yellow (2.5Y 7/4) dry; common fine light olive brown (2.5Y 5/6) and few fine grayish brown (2.5Y 5/2) distinct mottles; massive; soft and loose; nonsticky and nonplastic; strong effervescence; slightly alkaline; clear smooth boundary.

C2—33 to 43 inches; light olive brown (2.5Y 5/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish brown (10YR 5/6) and common fine distinct grayish brown (2.5Y 5/2) mottles; massive; soft and very friable; slightly sticky and slightly plastic; about 2 percent gravel in the lower part; common fine nests of gypsum crystals; slight effervescence; slightly alkaline; abrupt smooth boundary.

2C3—43 to 53 inches; olive gray (5Y 5/2) silty clay loam, white (5Y 8/2) dry; common medium and coarse prominent strong brown (7.5YR 4/6) mottles; massive; slightly hard and firm; sticky and plastic; few fine nests of gypsum crystals; strong effervescence; moderately alkaline; gradual wavy boundary.

2C4—53 to 60 inches; light yellowish brown (2.5Y 6/4) silty clay loam, pale yellow (2.5Y 8/4) dry; common fine olive gray (5Y 5/2) and few fine and medium strong brown (7.5YR 4/6) prominent mottles; massive; slightly hard and firm; sticky and plastic; very few fine nests of gypsum crystals; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The Ap horizon has value of 2 or 3 (3 to 5 dry). Some pedons have an ABk horizon. The Bk horizon has value of 3 to 6 (4 to 8 dry). The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 (5 to 8 dry), and chroma of 2 to 4. The 2C horizon has value of 4 to 6 (5 to 8 dry). It is silty clay loam or silt loam.

Zell Series

The Zell series consists of very deep, well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slopes range from 6 to 25 percent.

Typical pedon of Zell silt loam, in an area of Zell-Overly silt loams, 9 to 25 percent slopes, 250 feet east and 1,600 feet south of the northwest corner of sec. 26, T. 148 N., R. 54 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft and very friable; slightly sticky and slightly plastic; common fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—7 to 15 inches; light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) silt loam, pale yellow (2.5Y 7/4) and light gray (2.5Y 7/2) dry; massive; soft and very friable; slightly sticky and nonplastic; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C2—15 to 24 inches; light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) silt loam, pale yellow (2.5Y 7/4) and light gray (2.5Y 7/2) dry; massive; soft and very friable; slightly sticky and nonplastic; few thin soft accumulations of iron and manganese oxide along old root channels; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—24 to 41 inches; light yellowish brown (2.5Y 6/4) and light brownish gray (2.5Y 6/2), stratified silt loam and very fine sandy loam, pale yellow (2.5Y 7/4) and white (2.5Y 8/2) dry; massive; soft and very friable; nonsticky and nonplastic; few thin soft accumulations of iron and manganese oxide along old root channels; strong effervescence; moderately alkaline; clear smooth boundary.

C4—41 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; massive; soft and very friable; slightly sticky and nonplastic; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The Ap horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. Some pedons have a Bk horizon. The C horizon has value of 4 to 6 (6 to 8 dry).

Formation of the Soils

Soil forms through processes acting on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil. Some time is always required for the differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the chemical and mineralogical composition of the soil.

The soils in Steele County formed mainly in glacial drift. The advancing glacier picked up rocks and soil, ground and mixed them, and deposited them as it receded. Barnes, Svea, and other soils formed in unsorted material, or glacial till. Bearden, Gardena, and other soils formed in glaciolacustrine deposits, or material deposited by water in glacial lakes. Binford, Coe, and other soils formed in glaciofluvial deposits, or material deposited by glacial meltwater. Although the parent materials are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited.

A few of the soils in the county formed in material weathered from Cretaceous-aged Pierre shale. Examples are Edgeley and Kloten soils.

The parent materials in which most of the soils formed initially contained generous amounts of calcium and magnesium carbonate minerals. These minerals have been dissolved by water and removed from the upper horizons of the soils. Pure water is not effective in dissolving calcium and magnesium carbonates. These minerals are only slightly soluble in pure water but become moderately soluble and dissolve much more rapidly in a weak acid. The respiratory activity of plants is a significant factor in dissolving calcium and magnesium carbonates. As plant respire, they give off carbon dioxide. The carbon dioxide dissolves in the water in the soil and forms a weak carbonic acid. This action facilitates dissolution of calcium and magnesium carbonates in the soil.

In a dissolved state, calcium and magnesium are in the form of ions that have a positive net electrical charge. Calcium and magnesium ions are essential elements in plant nutrition and can either be taken up by plant roots or carried away (leached) by the water moving in the soil. Some of the calcium and magnesium ions are leached from the soil. Seep areas along steep slopes that have deposits of recently precipitated calcium and magnesium carbonates are evidence of leaching.

A large amount of the calcium and magnesium ions are translocated to the upper soil horizons by a cyclical process of root uptake and ultimate release when the plant materials decompose. As vegetation decays, positively charged calcium and magnesium ions move downward with water to the upper horizons of the soil. There, they are held by the electrostatic forces of negatively charged clay particles and are again available for plant uptake.

Climate

Climate has direct and indirect effects on the formation of soils. Precipitation, temperature, and wind directly affect the weathering and reworking of soil material. Climate indirectly affects soil formation through

its effects on the amount and kind of plant and animal life on or in the soil.

In addition to weathering soil material, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil. Freezing and thawing help to break down soil particles in the parent material, thereby providing more surface area for chemical processes. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

Steele County has a continental, subhumid climate characterized by long, cold winters and short, warm summers. The soils generally are frozen to a depth of 3 to 6 feet from November to April. During this time the soil-forming processes generally are dormant, although the soils are somewhat affected by frost action. The precipitation falls mainly during the growing season but is distributed in an erratic pattern. During this part of the year, the soil-forming processes influenced by climate are most active. The climate is fairly uniform throughout the county.

Plant and Animal Life

The soils in Steele County formed mainly under grassland vegetation. Grasses provide a plentiful supply of organic matter, which improves the chemical and physical properties of the soils. The fibrous roots of the grasses penetrate the soils to a depth of several feet, making them more porous and granular. As a result of these changes in the soils, less water runs off the surface and more moisture is available for increased microbiological activity. The decay of plants improves the available water capacity, tilth, and fertility of the soils. The accumulation of decayed organic matter over long periods darkens the surface layer.

In areas of the somewhat poorly drained or moderately well drained, nearly level soils, such as Gardena, Glyndon, Hamerly, Lankin, Overly, and Svea soils, the native vegetation is mainly tall and mid grasses. The principal grasses are big bluestem, switchgrass, indiangrass, and little bluestem.

In areas of the well drained or excessively drained, nearly level to steep soils, such as Brantford, Buse, and Coe soils, mid and short grasses are dominant. These grasses include green needlegrass, western wheatgrass, little bluestem, sideoats grama, plains muhly, and blue grama.

In areas of the poorly drained or very poorly drained soils in depressions, such as Arveson, Colvin, Parnell, and Tonka soils, the vegetation consists of tall grasses, reeds, rivergrass, slough sedge, American mannagrass, northern reedgrass, and prairie cordgrass.

Micro-organisms have important effects on soil formation because they feed on undecomposed organic matter and convert it into humus, from which plants can obtain nutrients. Bacteria and different kinds of fungi attack leaves and other forms of organic matter. Insects, earthworms, and small burrowing animals help to mix the humus with the soil.

Human activities greatly affect soil formation. Management measures can alter soil drainage. They can help to control erosion and maintain fertility. Poor management can increase the susceptibility to erosion and result in an unproductive soil.

Relief

Most of Steele County is nearly level to undulating, but some areas are rolling to steep. Many poorly drained and very poorly drained soils in depressions receive runoff from the higher adjacent areas. The steepest areas are on end moraines and breaks around rivers and drainageways. Local differences in relief within a square mile range from less than 10 feet to 150 feet.

Relief influences soil formation through its effect on drainage, runoff, and erosion. Many differences among the soils in the county result from variations in topographic position. Among these differences are those involving drainage, the thickness of the A horizon, the content of organic matter, the color of the subsoil, mottles in the subsoil, the thickness of the solum, and the degree of horizon differentiation.

In steep areas, runoff is rapid and only a small percentage of the rainfall penetrates the surface. Under these conditions, little moisture is available for plant growth and horizon development. The steep soils have a thin solum, a low content of organic matter, and weakly expressed horizons. Examples are Buse, Esmond, and Zell soils.

Nearly level to rolling soils are moderately well drained or well drained. They have enough moisture to support good stands of mixed native grasses. The soils have well developed profiles characterized by a black or very dark gray A horizon and a brown or very dark brown B horizon. Examples are Barnes, Egeland, and Heimdal soils. Most of the moderately well drained soils are in level or slightly concave areas. Generally, they are deeper to lime than the soils in convex, undulating or rolling areas and have a thicker A horizon and a darker B horizon. Examples are Emrick, Gardena, Overly, and Svea soils.

Soils in depressions that receive large amounts of runoff from the higher adjacent areas are somewhat poorly drained to very poorly drained. These soils vary widely in profile development, depending on the degree

of wetness. Parnell and Tonka soils, which are in shallow depressions, exhibit an advanced degree of horizonation because of the alternating wet and dry cycles that occur in the depressions. These soils have properties that are very similar to those of the soils in areas of much higher precipitation. They are examples of soils in which translocated clays have accumulated in the Bt horizon. Gleying, or the reduction and transfer of iron, has occurred in all of the very poorly drained to somewhat poorly drained soils in the county. In these naturally wet soils, this process has resulted in significant horizon differentiation. A gray color and mottles in the subsoil indicate the redistribution of reduced iron oxides. Southam soils, which are in deep depressions, are nearly continuously wet. They have a thick surface layer and have carbonates throughout. Horizonation in these soils is minimal and is mostly the result of sedimentary rather than soil-forming processes *(4)*.

Time

Soil formation is a very slow process. Much time is required for the processes of soil formation to act on the parent material and to form distinct horizons within the soil. Approximately 10,000 to 12,000 years have passed since the glaciers receded from Steele County. In geological terms, the soils in the county are young.

More time has been available for the formation of Barnes soils on glacial till plains than for the formation of Velva soils on flood plains. Since the glaciers receded, the processes of soil formation have been continually acting on the parent material of the Barnes soils. In contrast, Velva soils are continually gaining new parent material at the surface as a result of flooding. Barnes soils have well defined horizons, whereas Velva soils have weakly expressed horizons.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but

resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth, soil. The depth of the soil over bedrock. A very shallow soil is less than 10 inches deep over bedrock; a shallow soil, 10 to 20 inches; a moderately deep soil, 20 to 40 inches; a deep soil, 40 to 60 inches; and a very deep soil, more than 60 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and

the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sodium (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of the material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.
E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.
B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.
Cr horizon.—Soft, consolidated bedrock beneath the soil.
R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and are less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain. A nearly level area marking the floor of an extinct lake filled with well sorted, stratified sediments.

Large stones (in tables). Rock fragments 3 inches (7.6

centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and thickness.

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural

vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root shearing. The cutting, tearing, and disruption of plant roots by the hooves of animals in areas that are grazed when the soil is wet and soft.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline-sodic soil. A soil containing enough soluble salts and exchangeable sodium to interfere with the growth of plants.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the slope classes are:

Level	0 to 1 percent
Level and nearly level	0 to 3 percent
Nearly level	1 to 3 percent
Gently sloping or undulating	3 to 6 percent
Moderately sloping or gently rolling	6 to 9 percent
Strongly sloping or rolling	9 to 15 percent
Moderately steep or hilly	15 to 25 percent
Steep	25 to 35 percent
Very steep	more than 35 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones

adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. An E horizon below an A horizon. If the E horizon is exposed, it is called the surface layer.

Surface layer. An A horizon that is 4 to 9 inches (10 to 24 centimeters) thick.

Surface soil. An A horizon that is 10 inches (25 centimeters) or more thick.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). A layer of otherwise suitable soil material that is too thin for the specified use.

Till plain. An extensive area of nearly level to undulating soils underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-87 at Sharon, North Dakota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January	13.2	-5.5	3.9	42	-34	0	0.56	0.19	0.81	2	7.3
February	20.9	2.1	11.5	45	-28	0	.45	.13	.69	2	5.5
March	33.0	14.1	23.6	61	-19	32	.90	.19	1.39	3	6.5
April	52.6	30.1	41.4	84	6	168	1.62	.33	2.62	4	3.1
May	67.4	41.6	54.5	90	22	457	2.55	1.02	3.73	6	.3
June	74.9	51.2	63.1	92	35	693	3.41	2.04	4.48	8	.0
July	80.8	56.1	68.5	95	41	884	3.18	1.25	4.75	6	.0
August	80.2	54.0	67.1	97	37	840	2.62	1.15	3.69	6	.0
September	68.7	43.8	56.3	94	25	489	2.36	.77	3.63	5	.0
October	56.4	33.7	45.1	83	13	205	1.40	.29	2.19	4	1.0
November	35.2	17.3	26.3	65	-14	26	.79	.19	1.18	3	6.0
December	19.8	2.2	11.0	45	-28	0	.53	.20	.77	2	5.8
Yearly:											
Average	50.3	28.9	39.4	---	---	---	---	---	---	---	---
Extreme	---	---	---	98	-34	---	---	---	---	---	---
Total	---	---	---	---	---	3,794	20.37	16.57	24.01	51	35.5

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-87 at Sharon, North Dakota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 13	May 19	May 30
2 years in 10 later than--	May 8	May 14	May 25
5 years in 10 later than--	Apr. 27	May 5	May 17
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 25	Sept. 13	Sept. 8
2 years in 10 earlier than--	Oct. 1	Sept. 18	Sept. 12
5 years in 10 earlier than--	Oct. 11	Sept. 29	Sept. 22

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-87 at Sharon, North Dakota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	143	124	110
8 years in 10	151	132	116
5 years in 10	167	147	127
2 years in 10	182	161	138
1 year in 10	190	169	144

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
9	Aberdeen silty clay loam	670	0.1
43	Antler clay loam	2,420	0.5
64	Arveson loam	1,005	0.2
76	Arvilla sandy loam, 0 to 6 percent slopes	1,960	0.4
118	Barnes-Buse loams, 3 to 6 percent slopes	36,715	8.1
120	Barnes-Buse loams, 6 to 9 percent slopes	15,675	3.4
156	Barnes-Svea loams, 3 to 6 percent slopes	70,845	15.6
189	Bearden-Perella silty clay loams	5,350	1.2
296	Brantford loam, 0 to 3 percent slopes	5,935	1.3
314	Buse-Barnes loams, 9 to 15 percent slopes	7,085	1.5
319	Buse-Barnes loams, 15 to 35 percent slopes	4,180	0.9
391	Cavour-Cresbard loams, 0 to 3 percent slopes	970	0.2
450	Colvin silt loam	2,370	0.5
452	Colvin silt loam, saline	1,210	0.3
511	Divide loam, 0 to 3 percent slopes	4,410	1.0
539	Edgeley loam, 0 to 3 percent slopes	705	0.2
569	Embden fine sandy loam	4,110	0.9
579	Embden-Egeland fine sandy loams, 1 to 6 percent slopes	1,365	0.3
597	Emrick-Heimdal loams, 0 to 3 percent slopes	9,345	2.0
605	Esmond-Heimdal loams, 9 to 15 percent slopes	1,080	0.2
753	Fram-Wyard loams, 0 to 3 percent slopes	8,775	1.9
763	Gardena loam, 0 to 3 percent slopes	7,120	1.6
781	Gilby loam	8,735	1.9
796	Glyndon loam	3,100	0.7
866	Hamerly loam, 3 to 6 percent slopes	9,140	2.0
881	Hamerly-Tonka complex, 0 to 3 percent slopes	33,335	7.3
884	Hamerly-Wyard loams, 0 to 3 percent slopes	35,360	7.7
988	Heimdal-Emrick loams, 3 to 6 percent slopes	13,215	2.9
998	Heimdal-Esmond loams, 6 to 9 percent slopes	4,315	0.9
1031	Kratka fine sandy loam	2,095	0.5
1057	LaDelle silt loam, 0 to 3 percent slopes	3,950	0.9
1062	LaDelle silty clay loam, 0 to 3 percent slopes	220	*
1092	Lankin loam	9,120	2.0
1221	Maddock-Hecla loamy fine sands, 1 to 6 percent slopes	2,220	0.5
1267	Marysland loam	2,340	0.5
1404	Overly silty clay loam, 0 to 3 percent slopes	10,385	2.3
1427	Parnell silty clay loam	2,625	0.6
1466	Pits, sand and gravel	255	0.1
1710	Southam silty clay loam	4,855	1.1
1762	Svea-Barnes loams, 0 to 3 percent slopes	6,505	1.4
1765	Svea-Buse loams, 3 to 6 percent slopes	15,925	3.5
1766	Svea-Buse loams, 6 to 9 percent slopes	11,460	2.5
1769	Svea-Cresbard loams, 0 to 3 percent slopes	4,540	1.0
1780	Swenoda fine sandy loam	6,095	1.3
1883	Vallers-Parnell complex	8,845	1.9
1886	Vallers and Hamerly loams, saline, 0 to 3 percent slopes	8,400	1.8
1978	Water	1,495	0.3
2121	Miranda loam, 0 to 3 percent slopes	625	0.1
2151	Binford-Coe sandy loams, 0 to 6 percent slopes	8,635	1.9
2152	Coe-Binford complex, 6 to 25 percent slopes	4,235	0.9
2153	Edgeley-Kloten-Esmond complex, 9 to 35 percent slopes	1,805	0.4
2154	Glyndon-Tiffany loams	10,365	2.3
2155	Hecla loamy fine sand	1,570	0.3
2156	Lamoure and Rauville silt loams	9,545	2.1
2157	Maddock-Esmond-Embden complex, 6 to 15 percent slopes	995	0.2
2158	Velva fine sandy loam, 0 to 6 percent slopes	3,355	0.7
2159	Walsh silty clay loam, 1 to 6 percent slopes	335	0.1
2160	Wyndmere-Tiffany complex, silty substratum	5,980	1.3
2161	Zell-Overly silt loams, 6 to 9 percent slopes	2,895	0.6
2162	Zell-Overly silt loams, 9 to 25 percent slopes	4,205	0.9
2163	Antler clay loam, saline	1,425	0.3
	Total	457,800	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS

(Yields generally are those that can be expected under a high level of management. For poorly drained and very poorly drained soils, however, the yields are those expected in undrained areas. Absence of an entry indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Oats	Barley	Corn	Soybeans	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
9---------- Aberdeen	33	70	54	73	24	1,650	1.8
43---------- Antler	40	85	65	88	29	2,000	2.7
64---------- Arveson	14	30	23	31	10	700	2.8
76---------- Arvilla	19	40	31	42	14	950	1.9
118*---------- Barnes-Buse	26	55	42	57	19	1,300	2.1
120*---------- Barnes-Buse	20	43	33	44	15	1,000	2.0
156*---------- Barnes-Svea	33	70	54	73	24	1,650	2.6
189*---------- Bearden-Perella	41	87	67	90	30	2,050	2.8
296---------- Brantford	20	43	33	44	15	1,000	1.9
314*---------- Buse-Barnes	---	---	---	---	---	---	1.8
319*. Buse-Barnes							
391*---------- Cavour-Cresbard	24	51	39	53	18	1,200	1.7
450---------- Colvin	18	38	29	40	13	900	2.8
452---------- Colvin	9	19	15	20	7	450	2.1
511---------- Divide	25	53	41	55	18	1,250	2.3
539---------- Edgeley	32	68	52	70	23	1,600	1.9
569---------- Embden	34	72	55	75	25	1,700	2.5
579*---------- Embden-Egeland	29	62	47	64	21	1,450	2.5
597*---------- Emrick-Heimdal	34	72	55	75	25	1,700	2.7

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Corn	Soybeans	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
605*---------- Esmond-Heimdal	---	---	---	---	---	---	2.0
753*---------- Fram-Wyard	34	72	55	75	25	1,700	2.4
763---------- Gardena	44	94	72	97	32	2,200	2.9
781---------- Gilby	41	87	67	90	30	2,050	2.7
796---------- Glyndon	42	89	68	92	31	2,100	2.7
866---------- Hamerly	29	62	47	64	21	1,450	2.3
881*---------- Hamerly-Tonka	25	53	41	55	18	1,250	2.5
884*---------- Hamerly-Wyard	33	70	54	73	24	1,650	2.5
988*---------- Heimdal-Emrick	33	70	54	73	24	1,650	2.6
998*---------- Heimdal-Esmond	19	40	31	42	14	950	2.0
1031---------- Kratka	13	28	21	29	9	650	2.8
1057---------- LaDelle	44	94	72	97	32	2,200	3.3
1062---------- LaDelle	37	79	60	81	27	1,850	2.8
1092---------- Lankin	43	91	70	95	31	2,150	2.9
1221*---------- Maddock-Hecla	18	38	29	40	13	900	1.9
1267---------- Marysland	12	26	20	26	9	600	2.8
1404---------- Overly	44	94	72	97	32	2,200	2.9
1427---------- Parnell	9	19	15	20	7	450	---
1466*. Pits, sand and gravel							
1710. Southam							

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Corn	Soybeans	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
1762*---------- Svea-Barnes	36	77	59	79	26	1,800	2.7
1765*---------- Svea-Buse	28	60	46	62	20	1,400	2.2
1766*---------- Svea-Buse	22	47	36	48	16	1,100	2.0
1769*---------- Svea-Cresbard	32	68	52	70	23	1,600	2.4
1780---------- Swenoda	35	74	57	77	26	1,700	2.5
1883*---------- Vallers-Parnell	13	28	21	29	9	650	1.7
1886*---------- Vallers and Hamerly	10	21	16	22	7	500	2.1
1978*. Water							
2121---------- Miranda	---	---	---	---	---	---	0.9
2151*---------- Binford-Coe	12	26	20	26	9	600	1.4
2152*---------- Coe-Binford	---	---	---	---	---	---	0.5
2153*. Edgeley-Kloten-Esmond							
2154*---------- Glyndon-Tiffany	41	87	67	90	30	2,050	2.7
2155---------- Hecla	24	51	39	53	18	1,200	1.9
2156*---------- Lamoure and Rauville	---	---	---	---	---	---	1.4
2157*---------- Maddock-Esmond-Embden	---	---	---	---	---	---	1.7
2158---------- Velva	30	64	49	66	22	1,500	3.3
2159---------- Walsh	34	72	55	75	25	1,700	2.6
2160*---------- Wyndmere-Tiffany	26	55	42	57	19	1,300	2.7
2161*---------- Zell-Overly	22	47	36	48	16	1,100	2.1

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Corn	Soybeans	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
2162*---------- Zell-Overly	---	---	---	---	---	---	1.9
2163---------- Antler	22	47	36	48	16	1,100	2.1

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
314*, 319*:				
Buse	Thin Upland	2,800	2,500	2,100
Barnes	Silty	3,200	2,700	2,300
605*:				
Esmond	Thin Upland	2,800	2,500	2,100
Heimdal	Silty	3,200	2,700	2,300
2152*:				
Coe	Very Shallow	1,200	1,000	800
Binford	Shallow to Gravel	2,100	1,900	1,600
2153*:				
Edgeley	Silty	3,000	2,500	2,100
Kloten	Shallow	2,300	2,000	1,700
Esmond	Thin Upland	2,800	2,500	2,100

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on the soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
9---------- Aberdeen	---	Eastern redcedar, Siberian peashrub, Russian-olive, lilac, Peking cotoneaster, common chokecherry, silver buffaloberry.	Siberian elm, Siberian crabapple, green ash, ponderosa pine.	---	---
43---------- Antler	---	American plum, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
64---------- Arveson	---	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar, American plum.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
76---------- Arvilla	Silver buffaloberry, Siberian peashrub, lilac.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine----	---	---
118*, 120*: Barnes----------	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse----------	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm------	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
156*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
189*:					
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Peking cotoneaster, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Perella	---	Eastern redcedar, American plum, ponderosa pine, Siberian peashrub, redosier dogwood, common chokecherry, Peking cotoneaster.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
296 Brantford	Lilac, Siberian peashrub, silver buffaloberry.	Siberian crabapple, green ash, Russian-olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
314*: Buse.					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
319*: Buse.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
319*: Barnes.					
391*: Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
Cresbard	Peking cotoneaster	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
450 Colvin	---	American plum, Siberian peashrub, common chokecherry, lilac, eastern redcedar, redosier dogwood.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
452 Colvin	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
511 Divide	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
539 Edgeley	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
569 Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
579*:					
Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Egeland	---	Common chokecherry, Siberian peashrub, eastern redcedar, American plum, silver buffaloberry, Siberian crabapple, lilac.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
597*:					
Emrick	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
605*:					
Esmond.					
Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
753*:					
Fram	---	Redosier dogwood, ponderosa pine, Siberian peashrub, American plum, eastern redcedar, Peking cotoneaster, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Wyard	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
763 Gardena	---	American plum, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
781 Gilby	---	American plum, ponderosa pine, redosier dogwood, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
796 Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
866---------- Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
881*: Hamerly----------	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
Tonka----------	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
884*: Hamerly----------	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
Wyard----------	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
988*: Heimdal----------	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
988*: Emrick	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
998*: Heimdal	---	Eastern redcedar, lilac, American plum, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Esmond	Siberian peashrub	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
1031 Kratka	---	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar, American plum.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
1057 LaDelle	---	Ponderosa pine, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, green ash, Manchurian crabapple.	Golden willow	Eastern cottonwood.
1062 LaDelle	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1092--Lankin	---	American plum, ponderosa pine, redosier dogwood, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
1221*:					
Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, lilac, American plum, Siberian crabapple.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
Hecla	---	Eastern redcedar, American plum, ponderosa pine, Siberian peashrub, redosier dogwood, common chokecherry, Peking cotoneaster.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
1267--Marysland	---	Redosier dogwood, eastern redcedar, American plum, lilac, common chokecherry, Siberian peashrub.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow	Eastern cottonwood.
1404--Overly	---	Siberian peashrub, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
1427--Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1466*. Pits, sand and gravel					
1710. Southam					
1762*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
1765*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Buse	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
1766*:					
Svea	---	Lilac, Siberian peashrub, redosier dogwood, eastern redcedar, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub	Green ash, eastern redcedar, ponderosa pine, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1769*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Cresbard	Peking cotoneaster	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
1780 Swenoda	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
1883*:					
Vallers	---	Redosier dogwood, eastern redcedar, American plum, lilac, common chokecherry, Siberian peashrub.	Black Hills spruce, Siberian crabapple, green ash.	Golden willow	Eastern cottonwood.
Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
1886*:					
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
Hamerly	Silver buffaloberry, Siberian peashrub.	---	Siberian elm, Russian-olive, green ash.	---	---
1978*. Water					
2121. Miranda					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2151*:					
Binford	Siberian peashrub, lilac, silver buffaloberry.	Siberian crabapple, Rocky Mountain juniper, green ash, Russian-olive, eastern redcedar, common chokecherry.	Ponderosa pine	---	---
Coe.					
2152*:					
Coe.					
Binford.					
2153*:					
Edgeley.					
Kloten.					
Esmond.					
2154*:					
Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Tiffany	---	Redosier dogwood, ponderosa pine, American plum, Siberian peashrub, eastern redcedar, Peking cotoneaster, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
2155 Hecla	---	Eastern redcedar, American plum, ponderosa pine, Siberian peashrub, redosier dogwood, common chokecherry, Peking cotoneaster.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2156*:					
Lamoure	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, lilac, common chokecherry.	Green ash, Black Hills spruce, Manchurian crabapple.	Golden willow	Eastern cottonwood.
Rauville.					
2157*:					
Maddock.					
Esmond.					
Embden	---	Eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, Siberian peashrub, silver buffaloberry.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---
2158 Velva	---	Ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, redosier dogwood, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
2159 Walsh	---	Peking cotoneaster, redosier dogwood, American plum, Siberian peashrub, eastern redcedar, common chokecherry, ponderosa pine.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
2160*:					
Wyndmere	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2160*:					
Tiffany	---	Lilac, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
2161*:					
Zell	Siberian peashrub	Ponderosa pine, green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
Overly	---	Eastern redcedar, Tatarian honeysuckle, American plum, Siberian peashrub, lilac, redosier dogwood.	Ponderosa pine, Black Hills spruce, green ash, Russian-olive, bur oak, Siberian crabapple.	---	---
2162*:					
Zell.					
Overly	---	Eastern redcedar, Tatarian honeysuckle, American plum, Siberian peashrub, lilac, redosier dogwood.	Ponderosa pine, Black Hills spruce, green ash, Russian-olive, bur oak, Siberian crabapple.	---	---
2163 Antler	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the map unit was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
9--- Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
43--- Antler	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
64--- Arveson	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
76--- Arvilla	Slight	Slight	Moderate: slope.	Slight.
118*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
120*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
156*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
189*:				
Bearden	Moderate: wetness.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight.
Perella	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
296--- Brantford	Slight	Slight	Moderate: small stones.	Slight.
314*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
319*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
391*:				
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
450 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
452 Colvin	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
511 Divide	Slight	Slight	Slight	Slight.
539 Edgeley	Slight	Slight	Slight	Slight.
569 Embden	Slight	Slight	Slight	Slight.
579*:				
Embden	Slight	Slight	Moderate: slope.	Slight.
Egeland	Slight	Slight	Moderate: slope.	Slight.
597*:				
Emrick	Slight	Slight	Slight	Slight.
Heimdal	Slight	Slight	Slight	Slight.
605*:				
Esmond	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Heimdal	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
753*:				
Fram	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Wyard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
763 Gardena	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
781---------- Gilby	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
796---------- Glyndon	Slight----------	Slight----------	Slight----------	Slight.
866---------- Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
881*:				
Hamerly----------	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Tonka----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
884*:				
Hamerly----------	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Wyard----------	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
988*:				
Heimdal----------	Slight----------	Slight----------	Moderate: slope.	Slight.
Emrick----------	Slight----------	Slight----------	Moderate: slope.	Slight.
998*:				
Heimdal----------	Slight----------	Slight----------	Severe: slope.	Slight.
Esmond----------	Slight----------	Slight----------	Severe: slope.	Slight.
1031---------- Kratka	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1057, 1062---------- LaDelle	Severe: flooding.	Slight----------	Moderate: flooding.	Slight.
1092---------- Lankin	Slight----------	Slight----------	Slight----------	Slight.
1221*:				
Maddock----------	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Hecla----------	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1267--Marysland	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1404--Overly	Slight	Slight	Slight	Slight.
1427--Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1466*. Pits, sand and gravel				
1710--Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1762*:				
Svea	Slight	Slight	Moderate: small stones.	Slight.
Barnes	Slight	Slight	Moderate: small stones.	Slight.
1765*:				
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
1766*:				
Svea	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
1769*:				
Svea	Slight	Slight	Moderate: small stones.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
1780--Swenoda	Slight	Slight	Slight	Slight.
1883*:				
Vallers	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1886*:				
Vallers	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1886*: Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
1978*. Water				
2121 Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
2151*: Binford	Slight	Slight	Moderate: slope.	Slight.
Coe	Slight	Slight	Moderate: slope.	Slight.
2152*: Coe	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Moderate: slope.
Binford	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
2153*: Edgeley	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Kloten	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Moderate: slope.
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
2154*: Glyndon	Slight	Slight	Slight	Slight.
Tiffany	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
2155 Hecla	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
2156*: Lamoure	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
Rauville	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
2157*: Maddock	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2157*:				
Esmond	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Embden	Slight	Slight	Severe: slope.	Slight.
2158 Velva	Severe: flooding.	Slight	Moderate: slope, flooding.	Slight.
2159 Walsh	Slight	Slight	Moderate: slope, small stones.	Slight.
2160*:				
Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
Tiffany	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
2161*:				
Zell	Slight	Slight	Severe: slope.	Slight.
Overly	Slight	Slight	Severe: slope.	Slight.
2162*:				
Zell	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Overly	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
2163 Antler	Severe: wetness, excess salt.	Severe: excess salt.	Severe: wetness, excess salt.	Moderate: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the map unit was not rated)

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
9--Aberdeen	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
43--Antler	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
64--Arveson	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
76--Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
118*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
120*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
156*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
189*:									
Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Perella	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
296--Brantford	Fair	Fair	Good	Poor	Poor	Poor	Fair	Very poor	Fair.
314*:									
Buse	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
319*:									
Buse	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
391*:									
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
Cresbard	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
450--Colvin	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
452--Colvin	Poor	Fair	Poor	Fair	Good	Good	Poor	Good	Poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
511---------- Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
539---------- Edgeley	Good	Good	Good	Fair	Poor	Poor	Good	Very poor	Fair.
569---------- Embden	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
579*:									
Embden----------	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Egeland----------	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
597*:									
Emrick----------	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Heimdal----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
605*:									
Esmond----------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Heimdal----------	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
753*:									
Fram----------	Good	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
Wyard----------	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
763---------- Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
781---------- Gilby	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
796---------- Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
866---------- Hamerly	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
881*:									
Hamerly----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka----------	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
884*:									
Hamerly----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Wyard----------	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
988*:									
Heimdal----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
998*:									
Heimdal----------	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Esmond----------	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1031---------- Kratka	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
1057---------- LaDelle	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
1062---------- LaDelle	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
1092---------- Lankin	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
1221*:									
Maddock----------	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Hecla----------	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
1267---------- Marysland	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
1404---------- Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
1427---------- Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
1466*. Pits, sand and gravel									
1710---------- Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
1762*:									
Svea----------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
1765*:									
Svea----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse----------	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
1766*:									
Svea----------	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Buse----------	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
1769*:									
Svea----------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Cresbard----------	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
1780---------- Swenoda	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
1883*:									
Vallers----------	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Parnell----------	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1886*:									
Vallers	Poor	Fair	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
1978*. Water									
2121 Miranda	Poor	Poor	Very poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
2151*:									
Binford	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
Coe	Poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Fair.
2152*:									
Coe	Very poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Fair.
Binford	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
2153*:									
Edgeley	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Kloten	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Esmond	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
2154*:									
Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Tiffany	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
2155 Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
2156*:									
Lamoure	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Rauville	Very poor	Poor	Fair	Fair	Fair	Fair	Very poor	Fair	Fair.
2157*:									
Maddock	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Esmond	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Embden	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
2158 Velva	Fair	Good	Fair	Good	Poor	Very poor	Fair	Very poor	Fair.
2159 Walsh	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
2160*:									
Wyndmere	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
Tiffany	Poor	Fair	Good	Fair	Good	Fair	Fair	Fair	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
2161*:									
Zell	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Overly	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
2162*:									
Zell	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Overly	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
2163 Antler	Fair	Fair	Poor	Very poor	Fair	Fair	Fair	Fair	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
9 Aberdeen	Severe: cutbanks cave.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
43 Antler	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
64 Arveson	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
76 Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
118*, 120*: Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
156*: Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
189*: Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
Perella	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
296 Brantford	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
314*: Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
319*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
391*:					
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Cresbard	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
450 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
452 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness.
511 Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
539 Edgeley	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
569 Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
579*:					
Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
Egeland	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
597*:					
Emrick	Slight	Slight	Slight	Slight	Moderate: frost action.
Heimdal	Slight	Slight	Slight	Slight	Moderate: frost action.
605*:					
Esmond	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Heimdal	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
753*:					
Fram	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
753*:					
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
763—Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
781—Gilby	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
796—Glyndon	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
866—Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: frost action.
881*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
884*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
988*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Emrick	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
998*:					
Heimdal	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Esmond	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
1031—Kratka	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1057, 1062—LaDelle	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1092--- Lankin	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
1221*:					
Maddock---	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight.
Hecla---	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Moderate: frost action.
1267--- Marysland	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
1404--- Overly	Moderate: too clayey, wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
1427--- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
1466*. Pits, sand and gravel					
1710--- Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
1762*:					
Svea---	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes---	Slight---	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
1765*, 1766*:					
Svea---	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Buse---	Slight---	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
1769*:					
Svea---	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Cresbard---	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1780--- Swenoda	Moderate: wetness.	Slight---	Moderate: wetness, shrink-swell.	Slight---	Moderate: frost action.
1883*:					
Vallers---	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Parnell---	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
1886*:					
Vallers---	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
Hamerly---	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
1978*. Water					
2121--- Miranda	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, low strength, wetness.
2151*:					
Binford---	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight.
Coe---	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight.
2152*:					
Coe---	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Binford---	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
2153*:					
Edgeley---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Kloten---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Esmond---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
2154*:					
Glyndon---	Moderate: wetness.	Slight---	Moderate: wetness.	Slight---	Severe: frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2154*:					
Tiffany	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
2155 Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
2156*:					
Lamoure	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
Rauville	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
2157*:					
Maddock	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Esmond	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Embden	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
2158 Velva	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
2159 Walsh	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
2160*:					
Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Tiffany	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
2161*:					
Zell	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.
Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
2162*:					
Zell	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.
Overly	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2163---------- Antler	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
9--Aberdeen	Severe: percs slowly.	Moderate: seepage.	Severe: wetness, too clayey, too sandy.	Moderate: wetness.	Poor: too clayey, excess sodium.
43--Antler	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
64--Arveson	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
76--Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
118*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
120*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
156*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
189*:					
Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
Perella	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
296---------- Brantford	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
314*: Buse----------	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Barnes----------	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
319*: Buse----------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes----------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
391*: Cavour----------	Severe: percs slowly.	Slight----------	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Cresbard----------	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
450, 452---------- Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
511---------- Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
539---------- Edgeley	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock, hard to pack.
569---------- Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
579*: Embden----------	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
Egeland----------	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
597*: Emrick----------	Moderate: percs slowly.	Moderate: seepage.	Slight----------	Slight----------	Good.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
597*:					
Heimdal	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
605*:					
Esmond	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Heimdal	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
753*:					
Fram	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
763 Gardena	Moderate: wetness, percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
781 Gilby	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
796 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
866 Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
881*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
884*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
988*:					
Heimdal	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
988*:					
Emrick	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
998*:					
Heimdal	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
Esmond	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
1031 Kratka	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
1057 LaDelle	Severe: flooding.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Poor: hard to pack.
1062 LaDelle	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Fair: too clayey.
1092 Lankin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
1221*:					
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
1267 Marysland	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
1404 Overly	Severe: percs slowly.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Poor: thin layer.
1427 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
1466*. Pits, sand and gravel					
1710 Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1762*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
1765*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
1766*:					
Svea	Severe: percs slowly.	Severe: slope.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
1769*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
1780 Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
1883*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
1886*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
1978*. Water					

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2121 Miranda	Severe: wetness, percs slowly.	Slight	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
2151*: Binford	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Coe	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
2152*: Coe	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Binford	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
2153*: Edgeley	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, hard to pack, slope.
Kloten	Severe: seepage, thin layer, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: thin layer, slope, area reclaim.
Esmond	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
2154*: Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
Tiffany	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
2155 Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
2156*: Lamoure	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2156*:					
Rauville	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
2157*:					
Maddock	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Esmond	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Embden	Slight	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
2158 Velva	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Good.
2159 Walsh	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Poor: hard to pack.
2160*:					
Wyndmere	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Tiffany	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
2161*:					
Zell	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
Overly	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Poor: thin layer.
2162*:					
Zell	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Overly	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Poor: thin layer.
2163 Antler	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the map unit was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
9--- Aberdeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
43--- Antler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
64--- Arveson	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: wetness.
76--- Arvilla	Good---	Probable---	Probable---	Poor: too sandy, small stones, area reclaim.
118*, 120*:				
Barnes---	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Buse---	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
156*:				
Barnes---	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Svea---	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
189*:				
Bearden---	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Perella---	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
296--- Brantford	Good---	Probable---	Probable---	Poor: small stones, area reclaim.
314*:				
Buse---	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Barnes---	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
319*:				
Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
391*:				
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
450 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
452 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
511 Divide	Fair: wetness.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
539 Edgeley	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
569 Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
579*:				
Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Egeland	Good	Probable	Improbable: too sandy.	Fair: small stones.
597*:				
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
605*:				
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones,

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
753*:				
Fram	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Wyard	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
763 Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
781 Gilby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
796 Glyndon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
866 Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
881*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
884*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Wyard	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
988*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Emrick	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
998*:				
Heimdal	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1031 Kratka	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
1057, 1062 LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1092 Lankin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
1221*: Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Hecla	Good	Probable	Improbable: too sandy.	Poor: too sandy.
1267 Marysland	Poor: wetness.	Probable	Probable	Poor: wetness.
1404 Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
1427 Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1466*. Pits, sand and gravel				
1710 Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
1762*: Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Barnes	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
1765*, 1766*: Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
1769*: Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1780 Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
1883*: Vallers	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1886*: Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
1978*. Water				
2121 Miranda	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
2151*: Binford	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Coe	Good	Probable	Probable	Poor: small stones, area reclaim.
2152*: Coe	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Binford	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
2153*: Edgeley	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Kloten	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2153*:				
Esmond	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
2154*:				
Glyndon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Tiffany	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
2155 Hecla	Good	Probable	Improbable: too sandy.	Poor: too sandy.
2156*:				
Lamoure	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Rauville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
2157*:				
Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
2158 Velva	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
2159 Walsh	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
2160*:				
Wyndmere	Fair: thin layer, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Tiffany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
2161*:				
Zell	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
2162*:				
Zell	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2163---------- Antler	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the map unit was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
9---------- Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.
43---------- Antler	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
64---------- Arveson	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness----------	Wetness, too sandy.	Wetness.
76---------- Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
118*, 120*:						
Barnes----------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Buse----------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
156*:						
Barnes----------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Svea----------	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
189*:						
Bearden----------	Moderate: seepage.	Moderate: piping, hard to pack, wetness.	Percs slowly, frost action.	Wetness----------	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Perella----------	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness----------	Percs slowly.
296---------- Brantford	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, rooting depth.	Large stones, too sandy.	Large stones, droughty.
314*, 319*:						
Buse----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Barnes----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
391*:						
Cavour----------	Slight---------	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
391*:						
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
450 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
452 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
511 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
539 Edgeley	Moderate: seepage, depth to rock.	Severe: hard to pack.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
569 Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
579*:						
Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
Egeland	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty.	Too sandy, soil blowing.	Droughty.
597*:						
Emrick	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Heimdal	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
605*:						
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Heimdal	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
753*:						
Fram	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Wyard	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
763 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
781 Gilby	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
796 Glyndon	Severe: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
866---------- Hamerly	Moderate: slope.	Severe: piping.	Frost action, slope.	Slope, wetness.	Erodes easily, wetness.	Erodes easily.
881*:						
Hamerly----------	Slight---------	Severe: piping.	Frost action---	Wetness--------	Erodes easily, wetness.	Erodes easily.
Tonka----------	Slight---------	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
884*:						
Hamerly----------	Slight---------	Severe: piping.	Frost action---	Wetness--------	Erodes easily, wetness.	Erodes easily.
Wyard----------	Moderate: seepage.	Severe: piping, wetness.	Frost action---	Wetness--------	Erodes easily, wetness.	Wetness, erodes easily.
988*:						
Heimdal----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Emrick----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
998*:						
Heimdal----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Esmond----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
1031---------- Kratka	Severe: seepage.	Severe: piping, wetness.	Favorable------	Wetness, droughty.	Wetness, soil blowing.	Wetness, droughty, rooting depth.
1057---------- LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Flooding-------	Favorable------	Favorable.
1062---------- LaDelle	Slight---------	Moderate: thin layer, piping.	Deep to water	Flooding-------	Favorable------	Favorable.
1092---------- Lankin	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Favorable------	Erodes easily	Erodes easily.
1221*:						
Maddock----------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
Hecla----------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1267--------- Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness---------	Wetness, too sandy.	Wetness.
1404--------- Overly	Slight---------	Severe: piping.	Deep to water	Percs slowly---	Favorable------	Percs slowly.
1427--------- Parnell	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
1466*. Pits, sand and gravel						
1710--------- Southam	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
1762*:						
Svea---------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Barnes---------	Slight---------	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
1765*, 1766*:						
Svea---------	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Buse---------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
1769*:						
Svea---------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Cresbard---------	Slight---------	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable------	Excess sodium, percs slowly.
1780--------- Swenoda	Severe: seepage.	Severe: piping.	Favorable------	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
1883*:						
Vallers---------	Slight---------	Severe: piping, wetness.	Frost action---	Wetness---------	Wetness---------	Wetness.
Parnell---------	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
1886*:						
Vallers---------	Slight---------	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness---------	Wetness, excess salt.
Hamerly---------	Slight---------	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1978*. Water						
2121 Miranda	Slight	Severe: piping, excess sodium.	Percs slowly, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess sodium, percs slowly.
2151*:						
Binford	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty, rooting depth.
Coe	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, soil blowing.	Slope, droughty, soil blowing.	Large stones, droughty.
2152*:						
Coe	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty.	Slope, droughty.	Large stones, slope, droughty.
Binford	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.
2153*:						
Edgeley	Severe: slope.	Severe: hard to pack.	Deep to water	Slope, depth to rock.	Slope, depth to rock.	Slope, depth to rock.
Kloten	Severe: seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, area reclaim.	Slope, area reclaim.
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
2154*:						
Glyndon	Severe: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
Tiffany	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Wetness	Wetness.
2155 Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
2156*:						
Lamoure	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
Rauville	Severe: seepage.	Severe: hard to pack, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
2157*:						
Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
2157*:						
Esmond	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, soil blowing.	Soil blowing	Favorable.
2158 Velva	Severe: seepage.	Severe: piping.	Deep to water	Slope, soil blowing.	Soil blowing	Favorable.
2159 Walsh	Moderate: seepage, slope.	Severe: piping, hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
2160*:						
Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
Tiffany	Severe: seepage.	Severe: piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding	Wetness.
2161*:						
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Overly	Moderate: slope.	Severe: piping.	Deep to water	Slope, percs slowly.	Favorable	Percs slowly.
2162*:						
Zell	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Overly	Severe: slope.	Severe: piping.	Deep to water	Slope, percs slowly.	Slope	Slope, percs slowly.
2163 Antler	Severe: seepage.	Severe: wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.

*See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
9----------	0-12	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
Aberdeen	12-23	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	23-56	Silty clay loam, silt loam.	CL, CH, MH, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-55	7-25
	56-60	Stratified very fine sand to clay.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
43----------	0-9	Clay loam--------	CL, ML	A-6, A-7	0	100	100	90-100	80-95	35-50	10-25
Antler	9-22	Clay loam, silty clay loam, silt loam.	ML, CL	A-7, A-6	0-5	100	100	90-100	80-100	35-50	10-25
	22-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	85-100	60-80	20-50	10-25
64----------	0-18	Loam----------	ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
Arveson	18-35	Fine sandy loam, clay loam, loam.	SM, SC-SM	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	35-60	Fine sand, loamy sand, fine sandy loam.	SP-SM, SM, SC-SM	A-3, A-2, A-4	0	100	95-100	50-85	5-50	<20	NP-5
76----------	0-8	Sandy loam-------	SM, SC, SC-SM	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	<30	NP-15
Arvilla	8-17	Sandy loam, loam, coarse sandy loam.	SM, SC, SC-SM	A-2, A-4, A-6	0	90-100	85-100	50-80	20-45	<40	NP-15
	17-60	Gravelly coarse sand, coarse sand, sand.	SP-SM, GP, SM, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-15	---	NP
118*, 120*:											
Barnes----------	0-7	Loam----------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse----------	0-6	Loam----------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
156*:											
Barnes----------	0-7	Loam----------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea----------	0-8	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-23	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
189*:											
Bearden	0-8	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	8-17	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	17-60	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
Perella	0-13	Silty clay loam	CL, CL-ML	A-6, A-7, A-4	0	100	95-100	95-100	85-95	25-50	5-30
	13-22	Silt loam, silty clay loam.	CL, CL-ML, CH	A-4, A-7, A-6	0	100	95-100	95-100	50-100	25-60	5-40
	22-60	Silt loam, silty clay loam.	CL, CL-ML, ML	A-4, A-7, A-6	0	100	95-100	95-100	60-100	25-45	5-25
296 Brantford	0-14	Loam	ML, CL, CL-ML	A-4	0	90-100	85-95	80-90	60-80	15-25	NP-10
	14-18	Gravelly sandy loam.	ML, CL, CL-ML	A-4, A-6	0	90-100	65-95	60-90	55-80	20-35	NP-15
	18-60	Very gravelly loamy coarse sand, very gravelly coarse sand, gravelly sand.	SM, GP-GM, SP-SM, GM	A-1, A-2, A-3	5-25	50-95	30-75	15-60	5-30	<35	NP-10
314*, 319*:											
Buse	0-6	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
391*:											
Cavour	0-8	Loam	ML, MH	A-4, A-6, A-7	0	100	90-100	85-100	60-85	30-55	5-20
	8-27	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7, A-6	0	100	90-100	90-100	55-85	35-65	15-30
	27-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	90-100	75-100	50-85	35-65	12-35
Cresbard	0-10	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	10-20	Clay loam, silty clay.	CL, CH	A-7, A-6	0	95-100	90-100	90-100	65-85	30-60	15-30
	20-47	Clay loam, silty clay, clay.	CL, CH	A-7, A-6	0	95-100	90-100	85-100	65-85	40-60	15-30
	47-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	50-80	25-55	10-27
450 Colvin	0-8	Silt loam	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	8-32	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	32-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	95-100	100	90-100	70-95	25-50	10-25
452 Colvin	0-8	Silt loam	CL	A-6	0	100	100	90-100	80-95	20-35	10-20
	8-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
511---	0-9	Loam---	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
Divide	9-26	Loam, clay loam, gravelly sandy loam.	CL, CL-ML, SC-SM, SC	A-4, A-6, A-7	0-3	95-100	75-100	55-90	35-80	20-45	5-20
	26-60	Sand to very gravelly coarse sand.	GM, SM, GP-GM, SP-SM	A-1, A-3	0-5	25-100	15-100	10-70	5-25	<30	NP-5
539---	0-8	Loam---	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	85-95	60-75	20-40	5-25
Edgeley	8-36	Loam, silty clay loam, silt loam.	CL, CH, MH	A-6, A-7	0-5	80-100	75-100	65-95	55-95	25-75	10-40
	36-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
569---	0-10	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-75	<35	NP-10
Embden	10-36	Fine sandy loam, sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	25-55	---	NP
	36-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-100	15-50	---	NP
579*:											
Embden---	0-10	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-75	<35	NP-10
	10-36	Fine sandy loam, sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	25-55	---	NP
	36-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-100	15-50	---	NP
Egeland---	0-8	Fine sandy loam	SM, SC-SM	A-2, A-4	0	100	95-100	75-100	30-50	<30	NP-7
	8-37	Sandy loam, fine sandy loam.	SM, SC-SM	A-2, A-4	0	95-100	85-100	70-100	15-50	<30	NP-7
	37-60	Loamy fine sand, very fine sandy loam.	SM, SP-SM, SC-SM	A-2, A-4	0	95-100	85-100	70-100	10-45	<25	NP-5
597*:											
Emrick---	0-7	Loam---	ML	A-4	0-1	95-100	95-100	85-100	60-90	<40	NP-10
	7-36	Loam---	ML	A-4	0-1	95-100	95-100	85-95	55-75	<40	NP-10
	36-60	Loam, sandy loam	ML, SM, SC	A-4, A-6	0-5	90-100	90-100	60-100	35-90	<40	NP-10
Heimdal---	0-6	Loam---	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-19	Loam---	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	19-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
605*:											
Esmond---	0-7	Loam---	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
Heimdal---	0-6	Loam---	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-19	Loam---	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	19-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
753*:											
Fram---	0-7	Loam---	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Sandy loam, fine sandy loam, loam.	SM, ML	A-4	0-1	95-100	90-100	60-100	35-90	20-40	NP-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
753*:											
Wyard	0-26	Loam	CL-ML, CL	A-4, A-6, A-7	0	95-100	90-100	85-100	55-90	25-45	5-25
	26-60	Loam, clay loam	ML, CL, SC, CL-ML	A-4, A-6, A-7	0-10	95-100	90-100	80-100	35-85	20-45	3-25
763	0-17	Loam	ML, CL	A-4, A-6	0	100	100	75-100	60-100	25-40	NP-15
Gardena	17-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	55-100	20-40	NP-15
781	0-9	Loam	CL-ML, CL, ML	A-4	0-5	95-100	90-100	80-95	60-85	20-40	NP-10
Gilby	9-21	Loam, silt loam, very fine sandy loam.	CL-ML, CL, ML	A-4	0-5	95-100	90-100	80-95	50-85	20-40	NP-10
	21-60	Loam, clay loam	CL	A-6, A-7	0-10	95-100	90-100	80-95	65-80	25-50	10-25
796	0-7	Loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
Glyndon	7-30	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	30-60	Very fine sandy loam, silt loam.	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
866	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
Hamerly	9-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
881*:											
Hamerly	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	9-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Tonka	0-21	Silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	21-58	Silty clay loam, clay loam, silty clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	58-60	Clay loam, loam	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
884*:											
Hamerly	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	9-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Wyard	0-26	Loam	CL-ML, CL	A-4, A-6, A-7	0	95-100	90-100	85-100	55-90	25-45	5-25
	26-60	Loam, clay loam	ML, CL, SC, CL-ML	A-4, A-6, A-7	0-10	95-100	90-100	80-100	35-85	20-45	3-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
988*:											
Heimdal	0-6	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-19	Loam	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	19-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Emrick	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	<40	NP-10
	7-36	Loam	ML	A-4	0-1	95-100	95-100	85-95	55-75	<40	NP-10
	36-60	Loam, sandy loam	ML, SM, SC	A-4, A-6	0-5	90-100	90-100	60-100	35-90	<40	NP-10
998*:											
Heimdal	0-6	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	6-19	Loam	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	19-60	Loam, sandy loam	ML, SM, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	60-100	35-90	20-40	NP-15
Esmond	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
1031 Kratka	0-13	Fine sandy loam	SM, SC-SM	A-4	0	95-100	90-100	50-80	36-50	<25	2-6
	13-30	Loamy sand, sand, loamy fine sand.	SP-SM	A-3, A-2	0	95-100	90-100	50-80	5-10	---	NP
	30-60	Silty clay loam, silt loam.	MH, CH, CL-ML, CL	A-7, A-6	0	95-100	90-100	90-100	75-100	30-55	10-25
1057 LaDelle	0-20	Silt loam	ML, CL	A-4, A-6, A-7	0	100	100	90-100	75-100	30-45	7-20
	20-38	Silt loam, silty clay loam, loam.	CL, ML, MH, CH	A-6, A-7	0	100	100	90-100	75-100	30-55	10-25
	38-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	100	90-100	75-100	25-50	5-25
1062 LaDelle	0-24	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	24-44	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	44-60	Silty clay loam, silt loam.	CL, ML	A-4, A-6, A-7	0	100	100	90-100	75-100	30-50	5-25
1092 Lankin	0-10	Loam	ML, CL, CL-ML	A-4, A-6	0	95-100	90-100	80-100	60-90	20-40	3-20
	10-25	Loam, silt loam, clay loam.	ML, CL, CL-ML	A-4, A-6	0	95-100	90-100	80-100	60-90	20-40	3-20
	25-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	25-50	10-30
1221*:											
Maddock	0-11	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	11-60	Loamy fine sand, fine sand, sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Hecla	0-6	Loamy fine sand	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	6-31	Loamy fine sand, fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	31-60	Loamy sand, fine sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
1267----------	0-9	Loam----------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
Marysland	9-35	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	35-60	Fine sand to gravelly loamy coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
1404----------	0-14	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
Overly	14-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
1427----------	0-12	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
Parnell	12-50	Silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	50-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
1466*. Pits, sand and gravel											
1710----------	0-16	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	80-100	30-50	10-25
Southam	16-28	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	28-60	Silty clay, silty clay loam, loam.	CL, CH, CL-ML	A-6, A-7, A-4	0	100	95-100	85-100	60-100	20-75	5-50
1762*:											
Svea----------	0-18	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	18-28	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
Barnes----------	0-10	Loam----------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	10-28	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
1765*, 1766*:											
Svea----------	0-8	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-23	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
Buse----------	0-6	Loam----------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
1769*:											
Svea----------	0-8	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-23	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
1769*:											
Cresbard	0-10	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	10-20	Clay loam, silty clay.	CL, CH	A-7, A-6	0	95-100	90-100	90-100	65-85	30-60	15-30
	20-47	Clay loam, silty clay, clay.	CL, CH	A-7, A-6	0	95-100	90-100	85-100	65-85	40-60	15-30
	47-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	50-80	25-55	10-27
1780	0-15	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
Swenoda	15-30	Fine sandy loam, sandy loam, loamy fine sand.	SC-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-60	15-30	NP-10
	30-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	20-50	5-30
1883*:											
Vallers	0-13	Loam	ML, CL-ML	A-4	0-5	95-100	90-100	80-90	50-80	30-40	4-10
	13-26	Clay loam, loam	CL	A-6	0-5	95-100	90-100	80-95	50-80	30-40	11-20
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-85	20-40	5-20
Parnell	0-12	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	12-50	Silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	50-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
1886*:											
Vallers	0-13	Loam	ML	A-4	0-5	95-100	90-100	80-90	65-80	25-40	3-10
	13-26	Clay loam, loam	CL	A-6	0-5	95-100	90-100	80-95	50-80	30-40	10-20
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-20
Hamerly	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	9-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
1978*.											
Water											
2121	0-5	Loam	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	20-40	3-15
Miranda	5-11	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-30
	11-60	Loam, clay loam	CL, ML, SM	A-6, A-7, A-4	0-5	95-100	95-100	60-95	30-80	20-50	NP-30
2151*:											
Binford	0-6	Sandy loam	SM, SC, SC-SM	A-2, A-4	0	95-100	95-100	60-95	30-50	<30	NP-10
	6-15	Sandy loam, coarse sandy loam, loam.	SM, ML, SC, CL	A-2, A-4	0	95-100	95-100	60-85	30-60	10-30	NP-10
	15-60	Coarse sand, very gravelly coarse sand.	SM, GP-GM, GM, SP-SM	A-1, A-2, A-3	0	50-90	40-85	25-55	5-15	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
2151*:											
Coe	0-8	Sandy loam	ML, SM, CL-ML, SC-SM	A-2, A-4	0-5	95-100	95-100	60-80	30-55	<25	NP-5
	8-60	Gravelly sand, very gravelly loamy coarse sand, very gravelly coarse sand.	SM, GP-GM, SP-SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	<55	NP-15
2152*:											
Coe	0-8	Gravelly sandy loam.	SM, GM-GC, SC-SM, GM	A-4, A-2	0-10	50-80	40-70	30-60	25-50	<25	NP-5
	8-60	Gravelly sand, very gravelly loamy coarse sand, very gravelly coarse sand.	SM, GP-GM, SP-SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	<55	NP-15
Binford	0-6	Sandy loam	SM, SC, SC-SM	A-2, A-4	0	95-100	95-100	60-95	30-50	<30	NP-10
	6-15	Sandy loam, coarse sandy loam, loam.	SM, ML, SC, CL	A-2, A-4	0	95-100	95-100	60-85	30-60	10-30	NP-10
	15-60	Coarse sand, very gravelly coarse sand.	SM, GP-GM, GM, SP-SM	A-1, A-2, A-3	0	50-90	40-85	25-55	5-15	---	NP
2153*:											
Edgeley	0-8	Silt loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	85-95	60-75	20-40	5-25
	8-36	Loam, silty clay loam, silt loam.	CL, CH, MH	A-6, A-7	0-5	80-100	75-100	65-95	55-95	25-75	10-40
	36-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Kloten	0-7	Silt loam	CL, CL-ML	A-4, A-6	0-10	90-100	90-100	85-95	60-90	20-40	5-20
	7-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Esmond	0-7	Loam	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
2154*:											
Glyndon	0-7	Loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	7-30	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	30-60	Very fine sandy loam, silt loam.	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
Tiffany	0-8	Loam	ML, CL-ML, CL	A-4	0	100	100	85-95	50-80	15-35	NP-10
	8-45	Fine sandy loam, loam, loamy fine sand.	ML, SM, SC-SM	A-2, A-4	0	100	100	60-95	30-80	10-30	NP-10
	45-60	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
2155---------- Hecla	0-6	Loamy fine sand	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	6-31	Loamy fine sand, fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	12-35	<25	NP-7
	31-60	Loamy sand, fine sand, loamy fine sand.	SM, SC-SM, SP-SM	A-2	0	100	95-100	85-100	10-35	<25	NP-7
2156*:											
Lamoure---------	0-30	Silt loam--------	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	30-51	Silty clay loam, silt loam.	CL, CH, MH, ML	A-7, A-6	0	100	100	90-100	60-100	40-70	15-35
	51-60	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	95-100	95-100	90-100	60-100	30-70	10-35
Rauville--------	0-29	Silt loam--------	CL, ML	A-6, A-7	0	100	100	90-100	80-100	35-50	10-25
	29-46	Silty clay loam, silt loam, clay loam.	CL, CH, MH	A-6, A-7	0	100	100	90-100	85-100	35-60	15-28
	46-60	Stratified sand to silt loam.	SM, SC, CL, ML	A-2, A-4	0	80-100	65-95	50-85	15-70	<30	NP-10
2157*:											
Maddock---------	0-11	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	11-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Esmond----------	0-7	Loam----------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	7-60	Loam, sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0-5	90-100	85-100	60-100	35-90	20-40	NP-15
Embden----------	0-10	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-75	<35	NP-10
	10-36	Fine sandy loam, sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	25-55	---	NP
	36-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-100	15-50	---	NP
2158---------- Velva	0-6	Fine sandy loam	ML, SM, CL-ML, SC-SM	A-4	0	100	100	60-95	35-65	15-25	NP-5
	6-60	Fine sandy loam, loamy fine sand, loam.	ML, SM	A-4	0	100	100	70-95	40-75	20-30	NP-5
2159---------- Walsh	0-8	Silty clay loam	CL	A-6, A-7	0	95-100	85-100	80-100	70-90	30-50	10-30
	8-60	Clay loam, silty clay loam.	CL-ML, CL, MH	A-4, A-6, A-7	0	95-100	85-100	80-100	60-95	25-60	5-30
2160*:											
Wyndmere--------	0-8	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	10-30	NP-10
	8-29	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-90	30-55	10-30	NP-10
	29-53	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-100	20-55	---	NP
	53-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	100	90-100	70-95	20-45	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	3-10 inches	4	10	40	200		
	In				Pct					Pct	
2160*:											
Tiffany	0-8	Loam	ML, CL-ML, CL	A-4	0	100	100	85-95	50-80	15-35	NP-10
	8-45	Fine sandy loam, loamy fine sand, loamy very fine sand.	SM, ML	A-2, A-4	0	100	100	50-95	20-55	---	NP
	45-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	100	90-100	70-95	20-45	5-30
2161*, 2162*:											
Zell	0-7	Silt loam	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	7-60	Silt loam, very fine sandy loam, loam.	CL, ML, CL-ML	A-4, A-6 A-7	0	100	95-100	85-100	70-100	25-50	5-20
Overly	0-14	Silt loam	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	85-100	25-45	5-25
	14-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
2163	0-9	Clay loam	CL, ML	A-6, A-7	0	100	100	90-100	80-95	35-50	10-25
Antler	9-22	Silty clay loam, clay loam.	CL, ML	A-6, A-7	0	100	100	90-100	80-100	35-50	10-25
	22-60	Clay loam, loam	CL, ML	A-6, A-7	0-5	95-100	95-100	90-100	70-90	20-50	5-25

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
9----------	0-12	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.32	3	7
Aberdeen	12-23	0.06-0.2	0.13-0.18	6.6-8.4	<4	High------	0.32		
	23-56	0.06-0.2	0.14-0.17	7.4-9.0	2-8	High------	0.43		
	56-60	0.06-0.6	0.14-0.17	7.4-9.0	2-8	Low-------	0.43		
43----------	0-9	0.2-2.0	0.18-0.23	7.4-8.4	<2	Moderate	0.28	5	4L
Antler	9-22	0.2-0.6	0.15-0.20	7.9-8.4	<2	Moderate	0.37		
	22-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
64----------	0-18	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low-------	0.24	4	4L
Arveson	18-35	0.6-2.0	0.15-0.17	7.4-8.4	<2	Low-------	0.24		
	35-60	6.0-20	0.05-0.15	7.4-8.4	<2	Low-------	0.17		
76----------	0-8	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low-------	0.20	3	3
Arvilla	8-17	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low-------	0.20		
	17-60	>20	0.02-0.05	7.4-8.4	<2	Low-------	0.10		
118*, 120*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse----------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
156*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Svea----------	0-8	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-23	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	23-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
189*:									
Bearden---------	0-8	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	8-17	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	17-60	0.6-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.43		
Perella---------	0-13	0.2-0.6	0.18-0.23	6.6-7.8	<2	Moderate	0.28	5	7
	13-22	0.2-0.6	0.15-0.22	6.6-7.8	<2	Moderate	0.28		
	22-60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28		
296----------	0-14	0.6-2.0	0.17-0.22	6.6-7.8	<2	Low-------	0.28	3	5
Brantford	14-18	0.6-2.0	0.17-0.22	6.6-7.8	<2	Low-------	0.28		
	18-60	>20	0.02-0.05	7.4-8.4	<2	Low-------	0.10		
314*, 319*:									
Buse----------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
391*:									
Cavour	0-8	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	8-27	0.06-0.2	0.10-0.16	6.6-9.0	4-16	High	0.37		
	27-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
Cresbard	0-10	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low	0.32	3	6
	10-20	0.06-0.6	0.11-0.14	5.6-7.8	2-4	High	0.32		
	20-47	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High	0.32		
	47-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
450	0-8	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.32	5	4L
Colvin	8-32	0.2-0.6	0.16-0.20	7.4-8.4	<2	Moderate	0.32		
	32-60	0.2-0.6	0.15-0.20	7.4-8.4	<2	Moderate	0.32		
452	0-8	0.6-2.0	0.15-0.17	7.4-8.4	4-16	Moderate	0.32	5	4L
Colvin	8-60	0.2-0.6	0.11-0.15	7.4-8.4	4-16	Moderate	0.32		
511	0-9	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low	0.28	4	4L
Divide	9-26	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low	0.28		
	26-60	6.0-20	0.03-0.07	7.4-8.4	<2	Low	0.10		
539	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	0.28	4	6
Edgeley	8-36	0.6-2.0	0.13-0.19	6.1-8.4	<2	Moderate	0.28		
	36-60	0.01-0.2	---	---	---	---	----		
569	0-10	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low	0.20	5	3
Embden	10-36	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low	0.20		
	36-60	2.0-6.0	0.06-0.16	6.6-8.4	<2	Low	0.20		
579*:									
Embden	0-10	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low	0.20	5	3
	10-36	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low	0.20		
	36-60	2.0-6.0	0.06-0.16	6.6-8.4	<2	Low	0.20		
Egeland	0-8	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low	0.20	5	3
	8-37	2.0-6.0	0.09-0.15	6.1-7.8	<2	Low	0.20		
	37-60	2.0-6.0	0.08-0.10	6.6-8.4	<2	Low	0.20		
597*:									
Emrick	0-7	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	5
	7-36	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	36-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low	0.37		
Heimdal	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	6-19	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	19-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
605*:									
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
Heimdal	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	5
	6-19	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low	0.28		
	19-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low	0.37		
753*:									
Fram	0-7	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.13-0.20	7.4-8.4	<2	Low	0.37		
Wyard	0-26	0.6-2.0	0.20-0.24	6.6-7.8	<2	Moderate	0.28	5	6
	26-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
763----------	0-17	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	5
Gardena	17-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low-------	0.43		
781----------	0-9	0.6-2.0	0.17-0.24	7.4-8.4	<2	Low-------	0.28	5	4L
Gilby	9-21	0.6-2.0	0.17-0.22	7.9-8.4	<2	Low-------	0.28		
	21-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate	0.37		
796----------	0-7	0.6-2.0	0.20-0.23	7.4-8.4	<4	Low-------	0.28	5	4L
Glyndon	7-30	0.6-2.0	0.17-0.20	7.9-8.4	<4	Low-------	0.28		
	30-60	0.6-2.0	0.15-0.22	7.4-8.4	<4	Low-------	0.28		
866----------	0-9	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
Hamerly	9-37	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	37-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
881*:									
Hamerly---------	0-9	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	9-37	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	37-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka----------	0-21	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low-------	0.32	5	6
	21-58	0.06-0.2	0.14-0.19	5.6-7.8	<2	High------	0.43		
	58-60	0.2-0.6	0.14-0.19	6.6-8.4	<2	Moderate	0.43		
884*:									
Hamerly---------	0-9	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	9-37	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	37-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Wyard----------	0-26	0.6-2.0	0.20-0.24	6.6-7.8	<2	Moderate	0.28	5	6
	26-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
988*:									
Heimdal---------	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low-------	0.28	5	5
	6-19	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	0.28		
	19-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low-------	0.37		
Emrick----------	0-7	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	5
	7-36	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	0.28		
	36-60	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low-------	0.37		
998*:									
Heimdal---------	0-6	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low-------	0.28	5	5
	6-19	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	0.28		
	19-60	0.6-2.0	0.11-0.21	7.9-8.4	<2	Low-------	0.37		
Esmond----------	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low-------	0.37		
1031----------	0-13	2.0-6.0	0.13-0.18	5.6-7.8	<2	Low-------	0.17	5	3
Kratka	13-30	2.0-6.0	0.06-0.11	5.6-7.8	<2	Low-------	0.17		
	30-60	0.2-0.6	0.11-0.19	7.4-8.4	<2	Moderate	0.32		
1057----------	0-20	0.6-2.0	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	6
LaDelle	20-38	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
	38-60	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
1062----------	0-24	0.2-0.6	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	7
LaDelle	24-44	0.2-0.6	0.16-0.20	7.4-8.4	<4	Moderate	0.28		
	44-60	0.2-0.6	0.16-0.20	7.4-8.4	<4	Moderate	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
1092----------	0-10	0.6-2.0	0.17-0.24	6.6-7.3	<2	Moderate	0.28	5	6
Lankin	10-25	0.6-2.0	0.15-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate	0.37		
1221*:									
Maddock---------	0-11	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	11-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low-------	0.17		
Hecla----------	0-6	6.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17	5	2
	6-31	6.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17		
	31-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low-------	0.17		
1267----------	0-9	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
Marysland	9-35	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	35-60	6.0-20	0.02-0.07	7.9-8.4	<2	Low-------	0.15		
1404----------	0-14	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
Overly	14-60	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
1427----------	0-12	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
Parnell	12-50	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	50-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
1466*. Pits, sand and gravel									
1710----------	0-16	0.2-0.6	0.18-0.23	6.6-8.4	2-8	Moderate	0.37	5	4L
Southam	16-28	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High------	0.28		
	28-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High------	0.28		
1762*:									
Svea----------	0-18	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	18-28	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-10	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	10-28	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
1765*, 1766*:									
Svea----------	0-8	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-23	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	23-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse----------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
1769*:									
Svea----------	0-8	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-23	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	23-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Cresbard--------	0-10	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	10-20	0.06-0.2	0.11-0.14	5.6-7.8	2-4	High------	0.32		
	20-47	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	47-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
1780----------	0-15	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	0.20	5	3
Swenoda	15-30	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	0.20		
	30-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
1883*:									
Vallers	0-13	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low	0.28	5	4L
	13-26	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28		
	26-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low	0.28		
Parnell	0-12	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	12-50	0.06-0.2	0.13-0.19	6.1-7.8	<2	High	0.28		
	50-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	0.28		
1886*:									
Vallers	0-13	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low	0.28	5	4L
	13-26	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low	0.28		
	26-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low	0.28		
Hamerly	0-9	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	9-37	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	37-60	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		
1978*.									
Water									
2121	0-5	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low	0.32	3	6
Miranda	5-11	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	11-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
2151*:									
Binford	0-6	2.0-6.0	0.13-0.15	5.6-7.8	<2	Low	0.20	3	3
	6-15	2.0-6.0	0.12-0.18	5.6-8.4	<2	Low	0.20		
	15-60	6.0-20	0.02-0.08	5.6-8.4	<2	Low	0.10		
Coe	0-8	0.6-2.0	0.13-0.18	6.6-7.8	<2	Low	0.20	2	3
	8-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.15		
2152*:									
Coe	0-8	0.6-2.0	0.10-0.18	6.6-7.8	<2	Low	0.15	2	8
	8-60	>20	0.02-0.05	7.4-8.4	<2	Low	0.15		
Binford	0-6	2.0-6.0	0.13-0.15	5.6-7.8	<2	Low	0.20	3	3
	6-15	2.0-6.0	0.12-0.18	5.6-8.4	<2	Low	0.20		
	15-60	6.0-20	0.02-0.08	5.6-8.4	<2	Low	0.10		
2153*:									
Edgeley	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	0.28	4	6
	8-36	0.6-2.0	0.13-0.19	6.1-8.4	<2	Moderate	0.28		
	36-60	0.01-0.2	---	---	---	---	----		
Kloten	0-7	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	2	6
	7-60	0.01-0.2	---	---	---	---	----		
Esmond	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low	0.37		
2154*:									
Glyndon	0-7	0.6-2.0	0.20-0.23	7.4-8.4	<4	Low	0.28	5	4L
	7-30	0.6-2.0	0.17-0.20	7.9-8.4	<4	Low	0.28		
	30-60	0.6-2.0	0.15-0.22	7.4-8.4	<4	Low	0.28		
Tiffany	0-8	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low	0.28	5	5
	8-45	0.6-2.0	0.12-0.22	6.1-8.4	<2	Low	0.28		
	45-60	0.2-0.6	0.15-0.22	6.6-8.4	<2	Low	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
2155----------	0-6	6.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17	5	2
Hecla	6-31	6.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17		
	31-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low-------	0.17		
2156*:									
Lamoure---------	0-30	0.6-2.0	0.19-0.22	7.4-8.4	<4	Moderate	0.28	5	4L
	30-51	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	51-60	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
Rauville--------	0-29	0.6-2.0	0.19-0.22	7.4-8.4	<2	Moderate	0.28	5	4L
	29-46	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	46-60	2.0-6.0	0.08-0.15	7.4-8.4	<4	Low-------	0.10		
2157*:									
Maddock---------	0-11	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	11-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low-------	0.17		
Esmond----------	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	0.28	5	4L
	7-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low-------	0.37		
Embden----------	0-10	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low-------	0.20	5	3
	10-36	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	0.20		
	36-60	2.0-6.0	0.06-0.16	6.6-8.4	<2	Low-------	0.20		
2158----------	0-6	2.0-6.0	0.13-0.22	6.6-7.3	<2	Low-------	0.20	5	3
Velva	6-60	2.0-6.0	0.16-0.22	6.6-8.4	<2	Low-------	0.20		
2159----------	0-8	0.6-2.0	0.17-0.23	6.1-7.3	<2	Moderate	0.28	5	7
Walsh	8-60	0.2-0.6	0.14-0.22	6.1-7.8	<2	Moderate	0.43		
2160*:									
Wyndmere--------	0-8	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low-------	0.20	5	3
	8-29	2.0-6.0	0.12-0.17	7.4-8.4	<2	Low-------	0.20		
	29-53	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low-------	0.20		
	53-60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28		
Tiffany---------	0-8	2.0-6.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	5
	8-45	2.0-6.0	0.10-0.17	6.6-7.8	<2	Low-------	0.20		
	45-60	0.2-0.6	0.16-0.22	6.6-7.8	<2	Moderate	0.28		
2161*, 2162*:									
Zell----------	0-7	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low-------	0.32	5	4L
	7-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low-------	0.43		
Overly----------	0-14	0.2-0.6	0.22-0.24	6.6-7.8	<2	Moderate	0.32	5	6
	14-60	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
2163----------	0-9	0.6-2.0	0.10-0.15	7.4-7.8	4-16	Moderate	0.28	5	4L
Antler	9-22	0.2-0.6	0.10-0.15	7.9-8.4	4-16	Moderate	0.28		
	22-60	0.2-0.6	0.10-0.15	7.4-7.8	4-16	Moderate	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding," "water table," and terms such as "brief," "apparent," and "occasional" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
9--- Aberdeen	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Moderate.
43--- Antler	C	None	---	---	1.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.
64--- Arveson	B/D	None	---	---	0-2.0	Apparent	Apr-Jul	>60	---	High	High	Low.
76--- Arvilla	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
118*, 120*:												
Barnes	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
156*:												
Barnes	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
189*:												
Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.
Perella	B	None	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.
296--- Brantford	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
314*, 319*:												
Buse	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
391*:												
Cavour	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Moderate.
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Moderate.
450--- Colvin	C/D	None	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
452---------- Colvin	C/D	None	---	---	0-2.0	Apparent	Apr-Jul	>60	---	High	High	Moderate.
511---------- Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
539---------- Edgeley	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	Low.
569---------- Embden	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
579*:												
Embden----------	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
Egeland----------	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
597*:												
Emrick----------	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Heimdal----------	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
605*:												
Esmond----------	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Heimdal----------	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
753*:												
Fram----------	B	None	---	---	2.0-6.0	Apparent	Sep-Jun	>60	---	High	High	Low.
Wyard----------	B	None	---	---	1.0-3.0	Apparent	Mar-Jun	>60	---	High	High	Low.
763---------- Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High	Moderate	Low.
781---------- Gilby	B	None	---	---	1.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.
796---------- Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	---	High	High	Low.
866---------- Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.
881*:												
Hamerly----------	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
881*:												
Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High	High	Low.
884*:												
Hammerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.
Wyard	B	None	---	---	1.0-3.0	Apparent	Mar-Jun	>60	---	High	High	Low.
988*:												
Heimdal	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Emrick	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
998*:												
Heimdal	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Esmond	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
1031 Kratka	B/D	None	---	---	0.5-3.0	Apparent	Apr-Jul	>60	---	Moderate	High	Low.
1057, 1062 LaDelle	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Oct-Jun	>60	---	High	High	Low.
1092 Lankin	B	None	---	---	3.0-5.0	Apparent	Sep-Jun	>60	---	Moderate	High	Low.
1221*:												
Maddock	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	>60	---	Moderate	Moderate	Low.
1267 Marysland	B/D	None	---	---	0-2.0	Apparent	Nov-Jul	>60	---	High	High	Low.
1404 Overly	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High	High	Low.
1427 Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High	High	Low.
1466*. Pits, sand and gravel												
1710 Southam	D	None	---	---	+5-1.0	Apparent	Jan-Dec	>60	---	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
1762*:												
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
Barnes	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
1765*, 1766*:												
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low
1769*:												
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
1780 Swenoda	B	None	---	---	2.5-4.0	Perched	Mar-Jun	>60	---	Moderate	High	Moderate.
1883*:												
Vallers	C	None	---	---	1.0-2.5	Apparent	Nov-Jun	>60	---	High	High	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High	High	Low.
1886*:												
Vallers	C	None	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High	High	Moderate.
Hamerly	C	None	---	---	2.0-4.0	Apparent	Sep-Jun	>60	---	High	High	Moderate.
1978*. Water												
2121 Miranda	D	None	---	---	2.0-4.0	Apparent	Apr-Jul	>60	---	Moderate	High	Moderate.
2151*:												
Binford	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
Coe	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
2152*:												
Coe	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
Binford	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
2153*:												
Edgeley	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
2153*:												
Kloten	D	None	---	---	>6.0	---	---	9-20	Soft	Moderate	High	Low.
Esmond	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
2154*:												
Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	---	High	High	Low.
Tiffany	B	None	---	---	1.0-3.0	Apparent	Apr-Jun	>60	---	High	High	Low.
2155 Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	>60	---	Moderate	Moderate	Low.
2156*:												
Lamoure	C	Frequent	Brief	Mar-Oct	0-2.0	Apparent	Oct-Jun	>60	---	High	High	Moderate.
Rauville	D	Frequent	Brief	Mar-Oct	0-2.0	Apparent	Jan-Dec	>60	---	High	High	Moderate.
2157*:												
Maddock	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
Esmond	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Embden	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
2158 Velva	B	Occasional	Very brief to brief.	Mar-Jun	>6.0	---	---	>60	---	Moderate	High	Low.
2159 Walsh	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
2160*:												
Wyndmere	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	>60	---	High	High	Low.
Tiffany	B/D	None	---	---	+1-3.0	Apparent	Apr-Jun	>60	---	High	High	Low.
2161*, 2162*:												
Zell	B	None	---	---	>6.0	---	---	>60	---	High	High	Moderate.
Overly	C	None	---	---	>6.0	---	---	>60	---	High	High	Low.
2163 Antler	C	None	---	---	1.0-4.0	Apparent	Apr-Jun	>60	---	High	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aberdeen	Fine, montmorillonitic Glossic Udic Natriborolls
Antler	Fine-loamy, frigid Aeric Calciaquolls
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Binford	Sandy, mixed Udic Haploborolls
Brantford	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cavour	Fine, montmorillonitic Udic Natriborolls
Coe	Sandy-skeletal, mixed Udorthentic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Edgeley	Fine-loamy, mixed Udic Haploborolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Emrick	Coarse-loamy, mixed Pachic Udic Haploborolls
Esmond	Coarse-loamy, mixed Udorthentic Haploborolls
Fram	Coarse-loamy, frigid Aeric Calciaquolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Gilby	Fine-loamy, frigid Aeric Calciaquolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Hecla	Sandy, mixed Aquic Haploborolls
Heimdal	Coarse-loamy, mixed Udic Haploborolls
Kloten	Loamy, mixed, shallow Udorthentic Haploborolls
Kratka	Sandy over loamy, mixed, frigid Typic Haplaquolls
LaDelle	Fine-silty, mixed Cumulic Udic Haploborolls
Lamoure	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Lankin	Fine-loamy, mixed Pachic Udic Haploborolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Miranda	Fine-loamy, mixed Leptic Natriborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Perella	Fine-silty, mixed, frigid Typic Haplaquolls
Rauville	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tiffany	Coarse-loamy, mixed, frigid Typic Haplaquolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Velva	Coarse-loamy, mixed Fluventic Haploborolls
Walsh	Fine-loamy, mixed Pachic Udic Haploborolls
Wyard	Fine-loamy, mixed, frigid Typic Haplaquolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls
Zell	Coarse-silty, mixed Udorthentic Haploborolls

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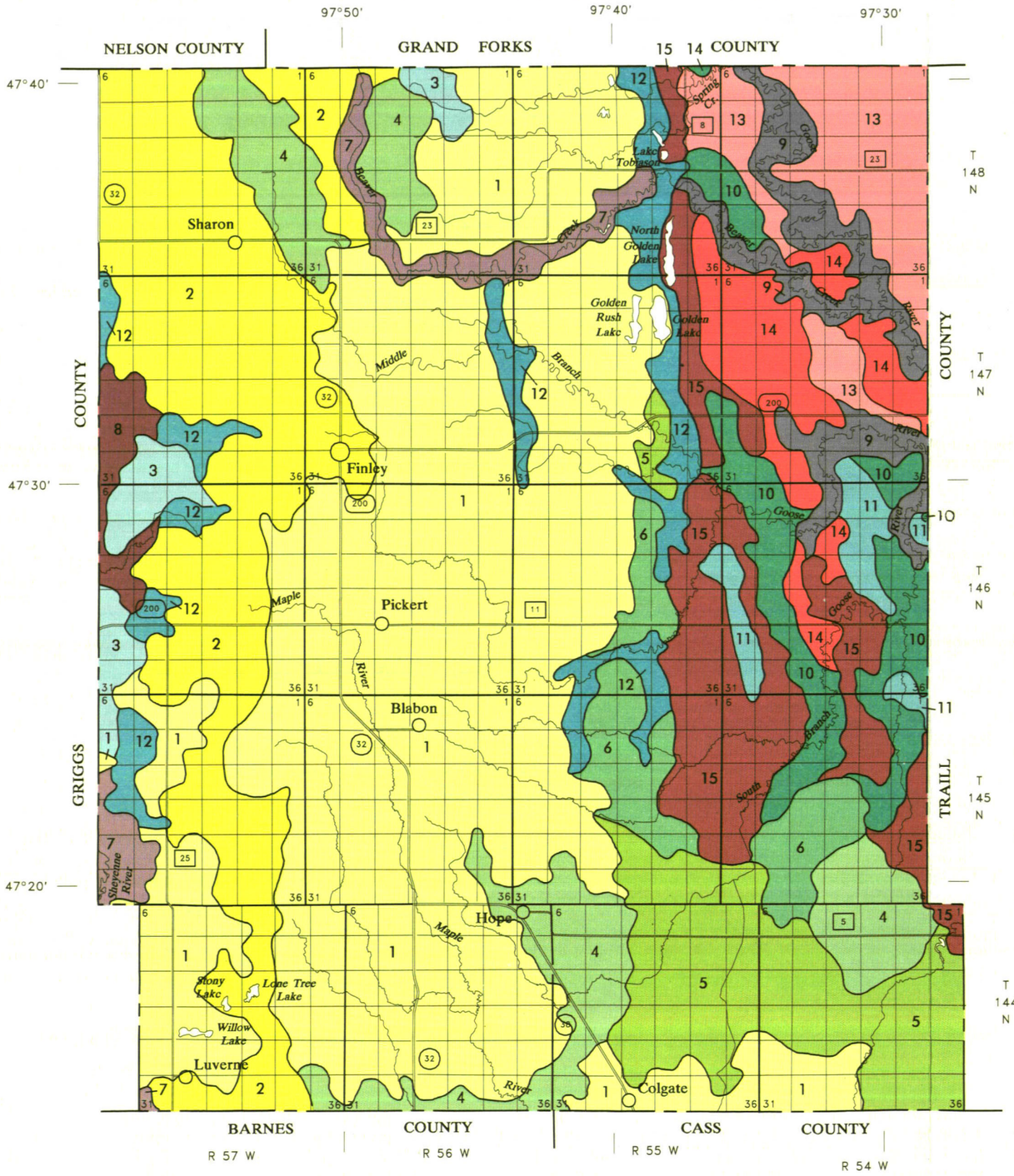


Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND *

LEVEL TO GENTLY ROLLING, LOAMY AND SILTY SOILS ON TILL PLAINS

1 Barnes–Hamerly–Svea association
2 Svea–Buse–Parnell association
3 Cresbard–Svea–Hamerly association
4 Hamerly–Tonka–Barnes association
5 Heimdal–Emrick association
6 Fram–Emrick–Heimdal association

LEVEL TO STEEP, LOAMY AND SILTY SOILS IN VALLEYS AND ON TILL PLAINS, FLOOD PLAINS, AND LAKE PLAINS

7 Buse–Barnes–Lamoure association
8 Edgeley–Esmond–LaDelle association
9 LaDelle–Overly–Zell association

LEVEL TO UNDULATING, LOAMY AND SANDY SOILS ON DELTA PLAINS, LAKE PLAINS, OUTWASH PLAINS, TILL PLAINS, AND TERRACES

10 Wyndmere–Tiffany–Swenoda association
11 Hecla–Arvilla–Arveson association
12 Binford–Divide–Coe association

LEVEL AND NEARLY LEVEL, LOAMY AND SILTY SOILS ON LAKE PLAINS

13 Glyndon–Gardena association
14 Overly–Bearden association
15 Lankin–Gilby–Antler association

*The units on this legend are described in the text

Compiled 1991

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE

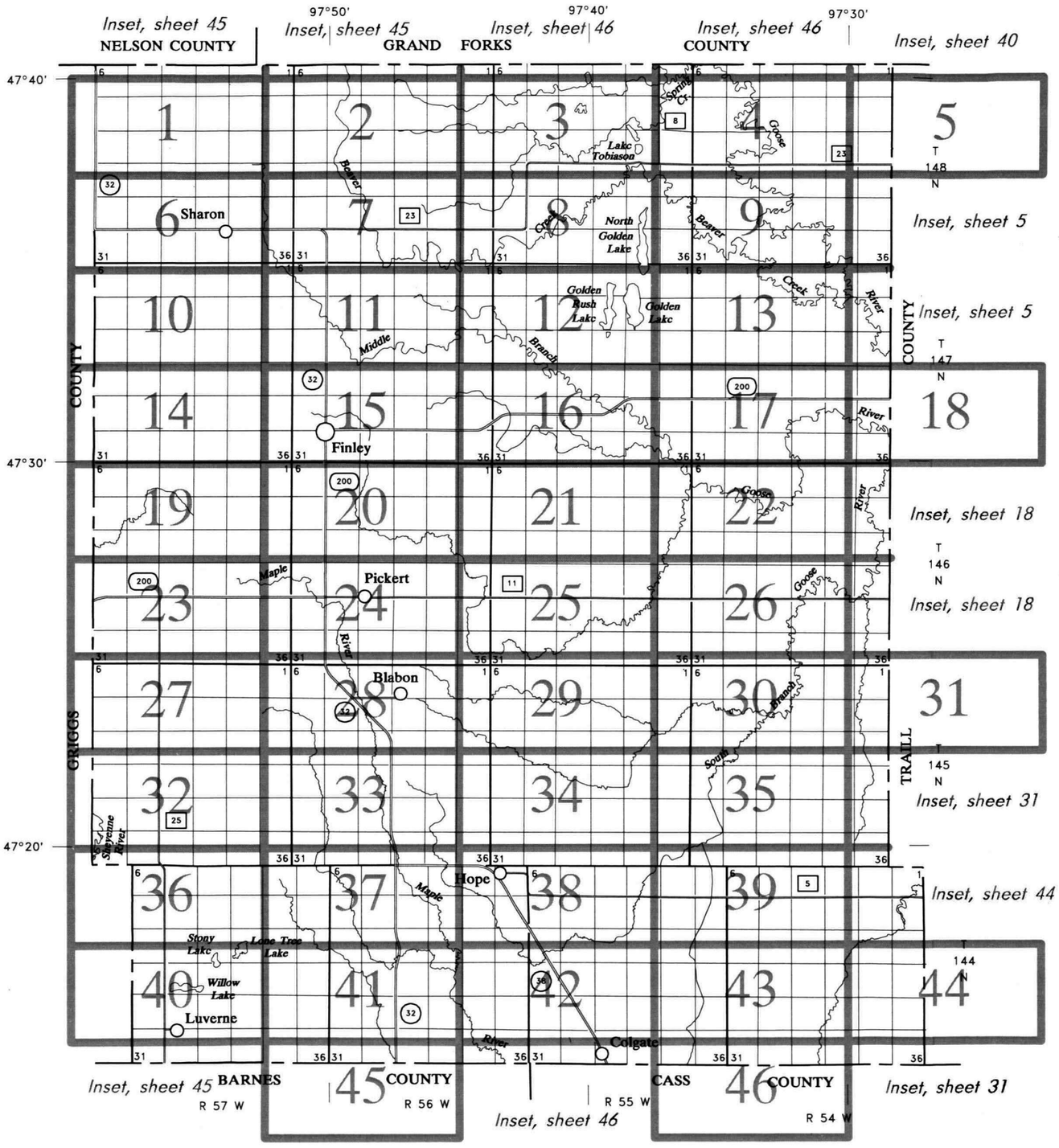
GENERAL SOIL MAP

STEELE COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

STEELE COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

SOIL LEGEND

Publication symbols consist of a four digit number from the State Soil Legend, however, the prefix zeroes will not be used on the maps or in the text of the published report. For example, symbol 0043 will occur as 43 on the maps and in the text of the published report.

SYMBOL	NAME
0009	Aberdeen silty clay loam
0043	Antler clay loam
0064	Arveson loam
0076	Arvilla sandy loam, 0 to 6 percent slopes
0118	Barnes-Buse loams, 3 to 6 percent slopes
0120	Barnes-Buse loams, 6 to 9 percent slopes
0156	Barnes-Svea loams, 3 to 6 percent slopes
0189	Bearden-Perella silty clay loams
0296	Brantford loam, 0 to 3 percent slopes
0314	Buse-Barnes loams, 9 to 15 percent slopes
0319	Buse-Barnes loams, 15 to 35 percent slopes
0391	Cavour-Cresbard loams, 0 to 3 percent slopes
0450	Colvin silt loam
0452	Colvin silt loam, saline
0511	Divide loam, 0 to 3 percent slopes
0539	Edgeley loam, 0 to 3 percent slopes
0569	Embden fine sandy loam
0579	Embden-Egeland fine sandy loams, 1 to 6 percent slopes
0597	Emrick-Heimdal loams, 0 to 3 percent slopes
0605	Esmond-Heimdal loams, 9 to 15 percent slopes
0753	Fram-Wyard loams, 0 to 3 percent slopes
0763	Gardena loam, 0 to 3 percent slopes
0781	Gilby loam
0796	Glyndon loam
0866	Hamerly loam, 3 to 6 percent slopes
0881	Hamerly-Tonka complex, 0 to 3 percent slopes
0884	Hamerly-Wyard loams, 0 to 3 percent slopes
0988	Heimdal-Emrick loams, 3 to 6 percent slopes
0998	Heimdal-Esmond loams, 6 to 9 percent slopes
1031	Kratka fine sandy loam
1057	LaDelle silt loam, 0 to 3 percent slopes
1062	LaDelle silty clay loam, 0 to 3 percent slopes
1092	Lankin loam
1221	Maddock-Hecla loamy fine sands, 1 to 6 percent slopes
1267	Marysland loam
1404	Overly silty clay loam, 0 to 3 percent slopes
1427	Parnell silty clay loam
1466	Pits, sand and gravel
1710	Southam silty clay loam
1762	Svea-Barnes loams, 0 to 3 percent slopes
1765	Svea-Buse loams, 3 to 6 percent slopes
1766	Svea-Buse loams, 6 to 9 percent slopes
1769	Svea-Cresbard loams, 0 to 3 percent slopes
1780	Swenoda fine sandy loam
1883	Vallers-Parnell complex
1886	Vallers and Hamerly loams, saline, 0 to 3 percent slopes
1978	Water
2121	Miranda loam, 0 to 3 percent slopes
2151	Binford-Coe sandy loams, 0 to 6 percent slopes
2152	Coe-Binford complex, 6 to 25 percent slopes
2153	Edgeley-Kloten-Esmond complex, 9 to 35 percent slopes
2154	Glyndon-Tiffany loams
2155	Hecla loamy fine sand
2156	Lamoure and Rauville silt loams
2157	Maddock-Esmond-Embden complex, 6 to 15 percent slopes
2158	Velva fine sandy loam, 0 to 6 percent slopes
2159	Walsh silty clay loam, 1 to 6 percent slopes
2160	Wyndmere-Tiffany complex, silty substratum
2161	Zell-Overly silt loams, 6 to 9 percent slopes
2162	Zell-Overly silt loams, 9 to 25 percent slopes
2163	Antler clay loam, saline

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state, or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label)

Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK
1 890 000 FEET

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate (173)
- Federal (287)
- State (52)
- County, farm or ranch (5)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small > 3 acres (Named where applicable) (1978)

PITS

- Gravel pit 1/2 to 3 acres
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban area) (occupied)
- Church rural only
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (Gas)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end

Canals or ditches

- Double-line (label) (CANAL)
- Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial > 3 acres (1978)
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or spring
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (1710 1883)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

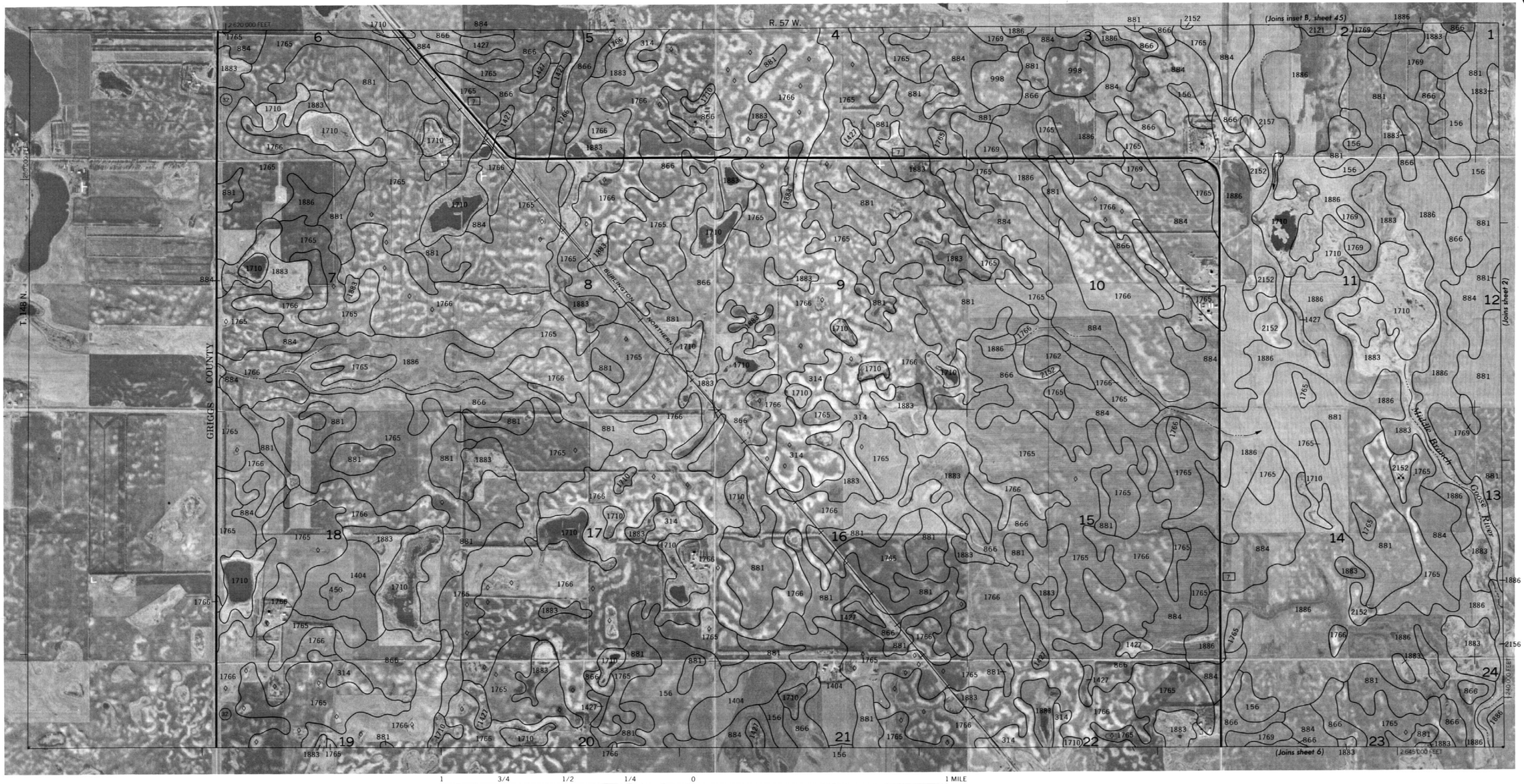
DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

SOIL SURVEY OF STEELE COUNTY, NORTH DAKOTA — SHEET NUMBER 1

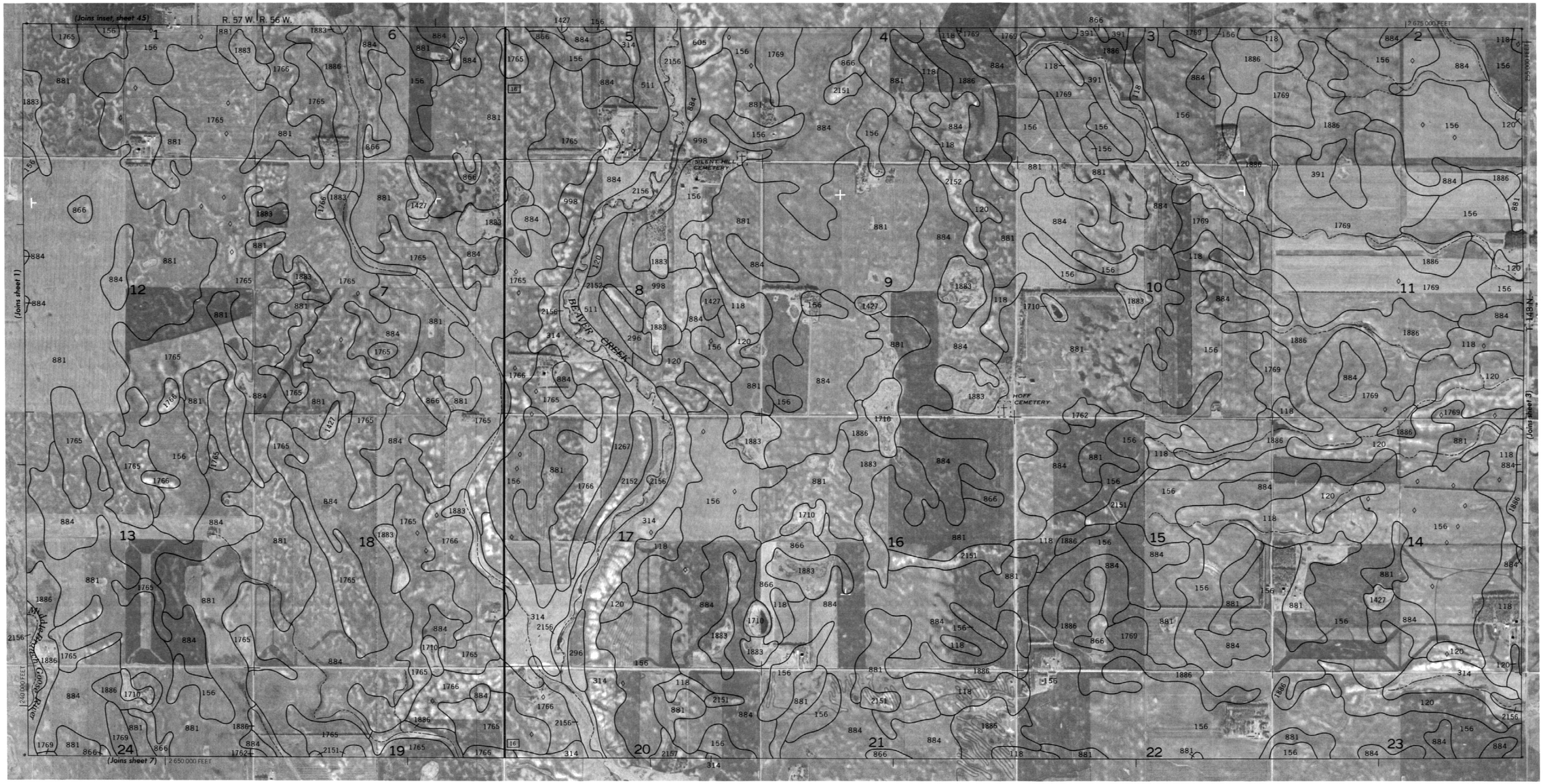


N

STEELE COUNTY, NORTH DAKOTA NO. 1

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF STEELE COUNTY, NORTH DAKOTA — SHEET NUMBER 2



1 3/4 1/2 1/4 0 1 MILE

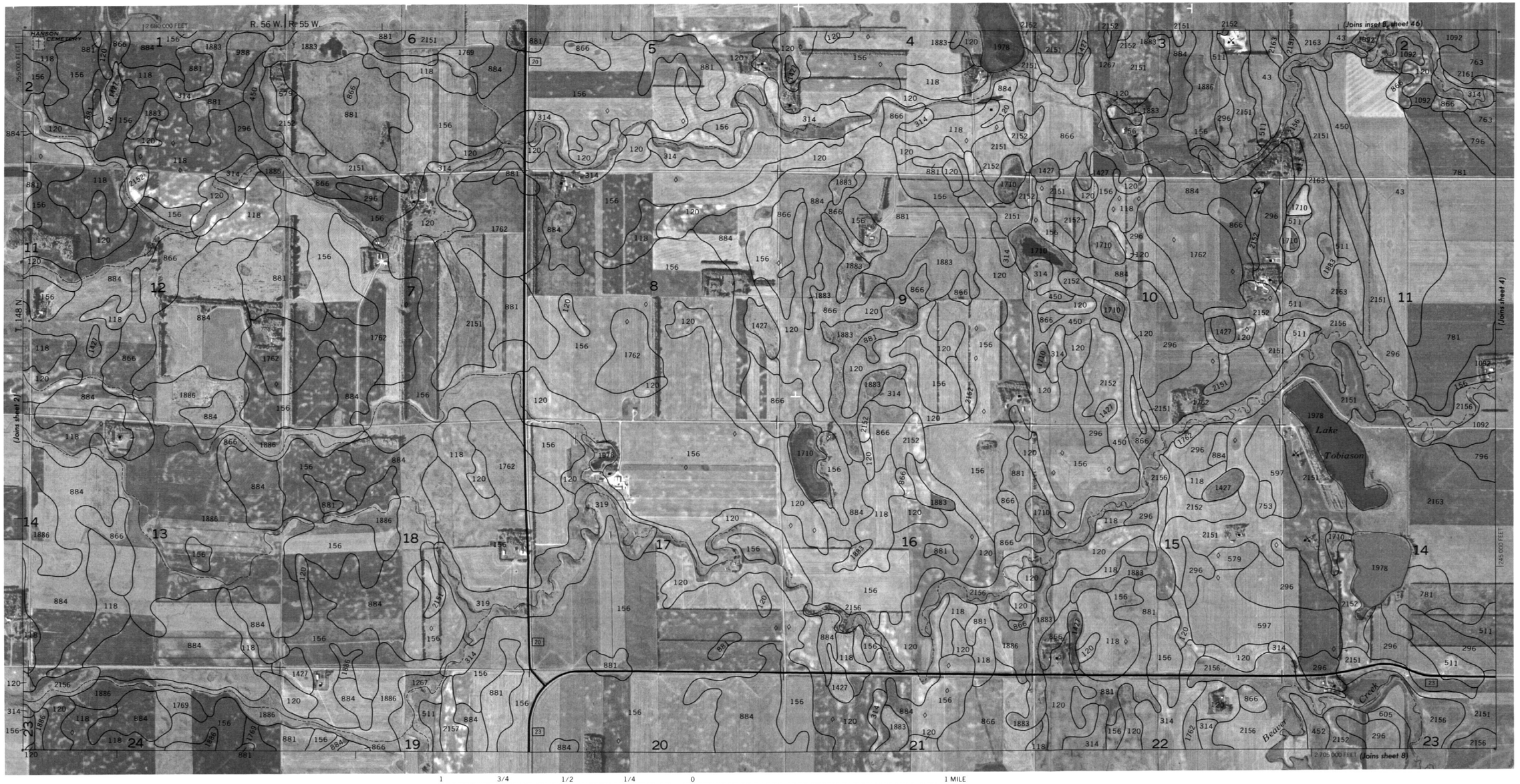
1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 2

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned

N



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 3

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1981–1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 4

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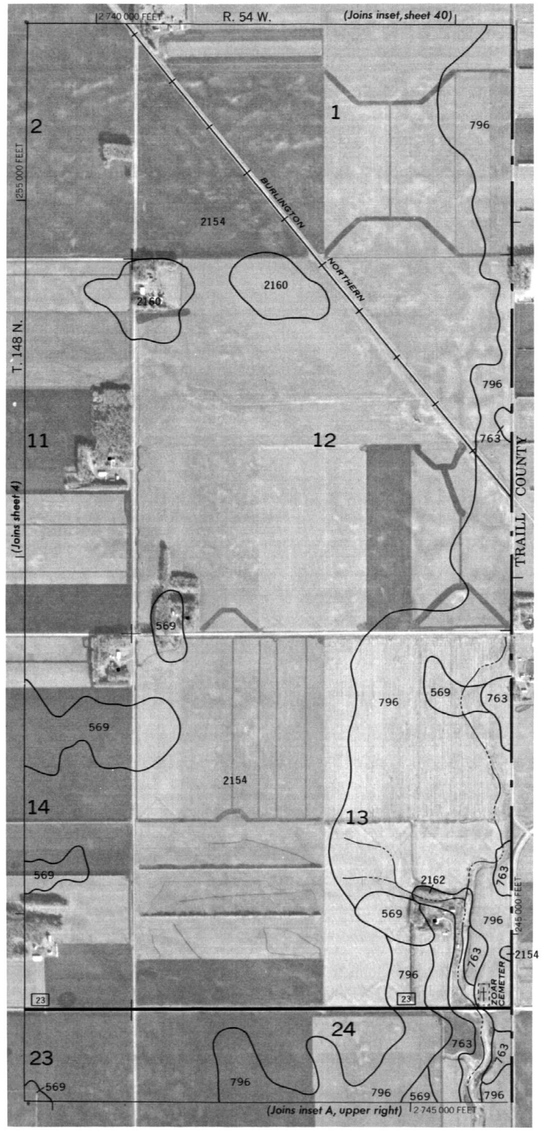
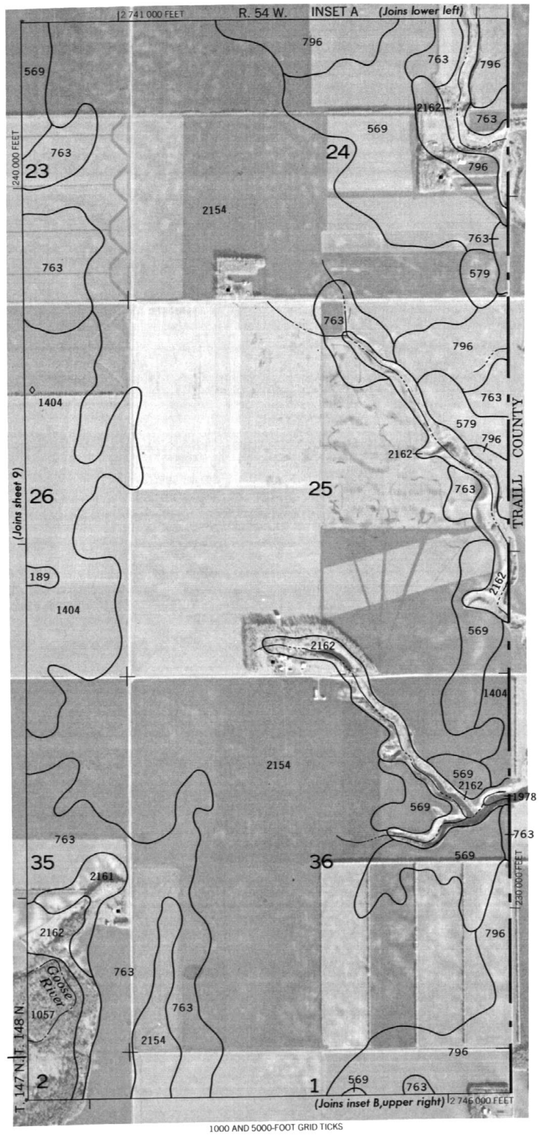
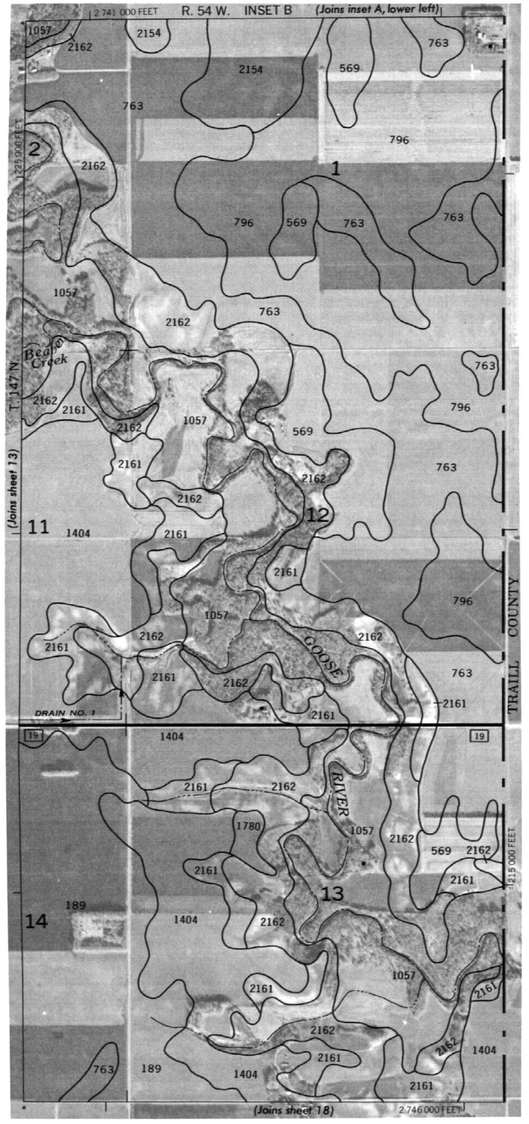
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 5







1000 AND 5000-FOOT GRID TICKS

1 3/4 1/2 1/4 0 1 MILE

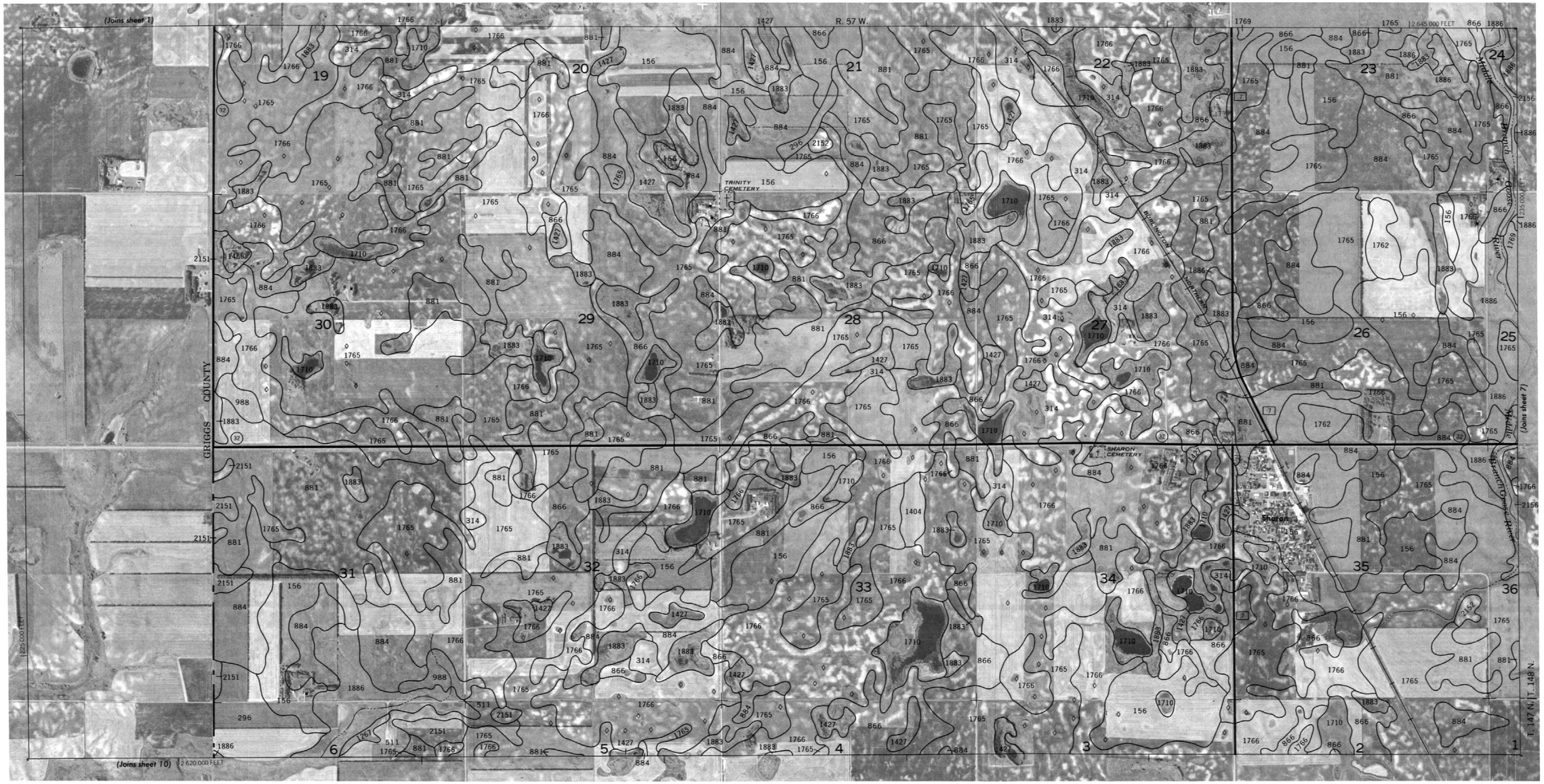
1 0.5 0 1 KILOMETER

SCALE 1:20 000

1000 AND 5000-FOOT GRID TICKS

5

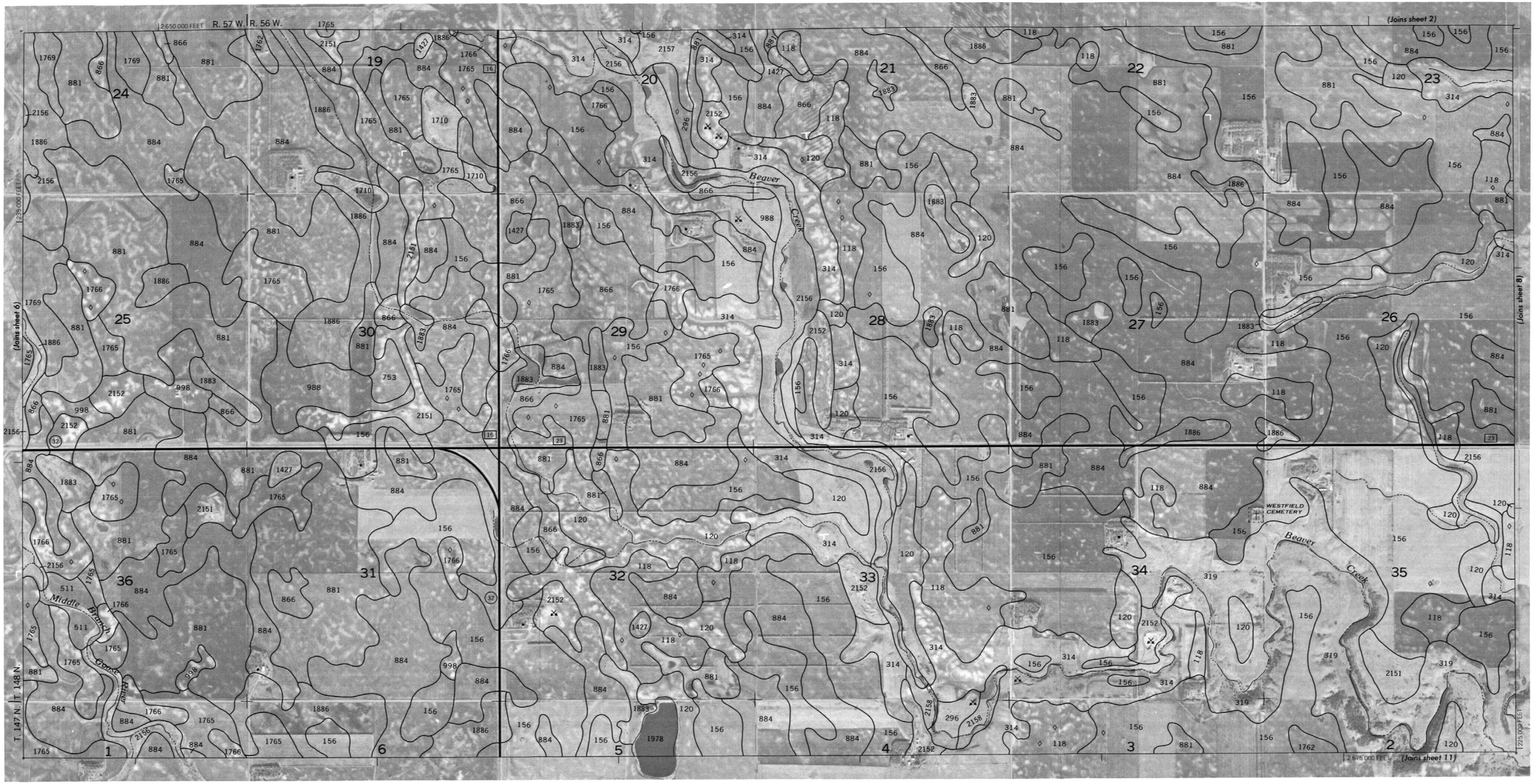
N



STEELE COUNTY, NORTH DAKOTA NO. 6

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 7

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 8

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

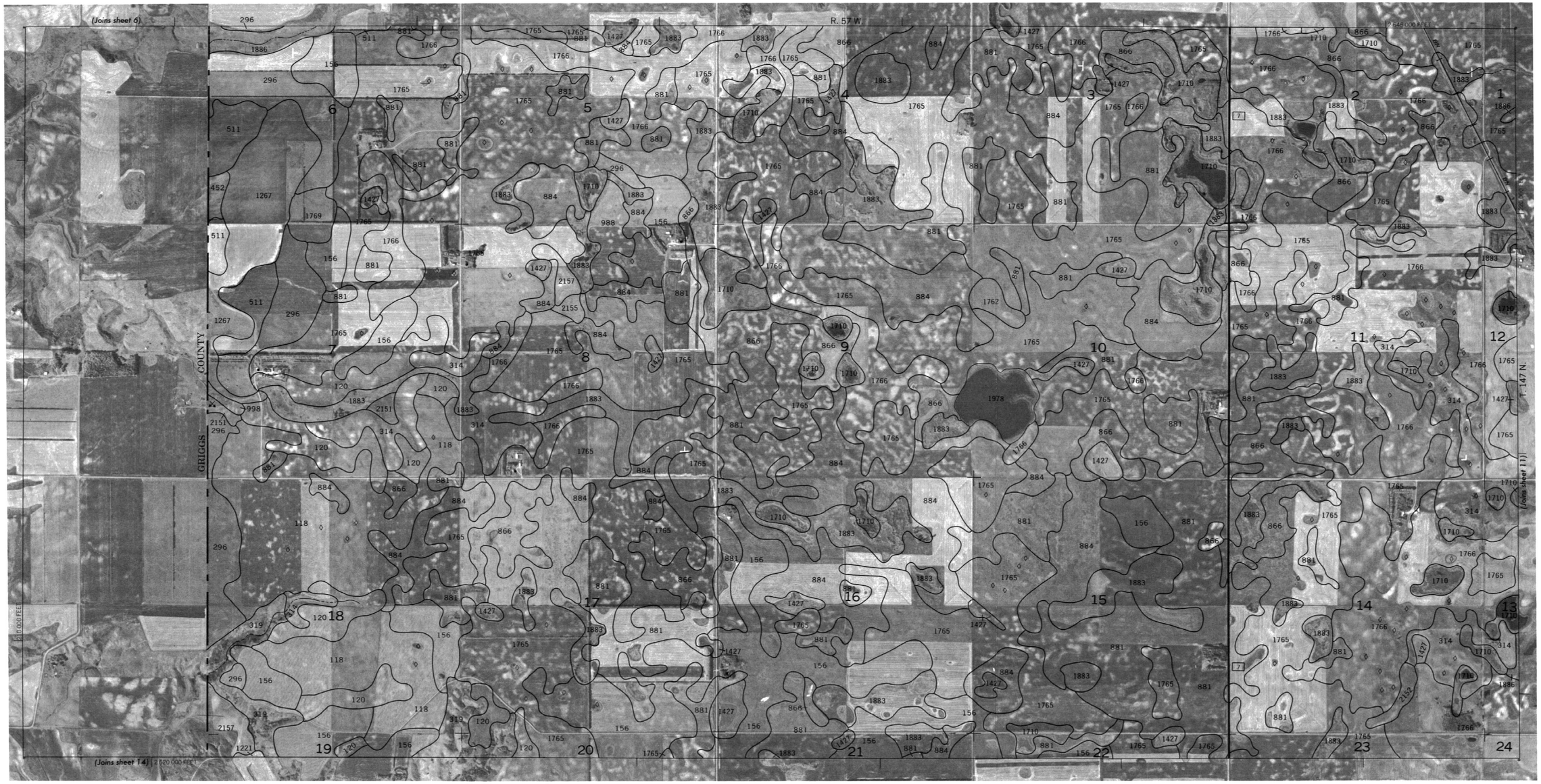
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 9

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



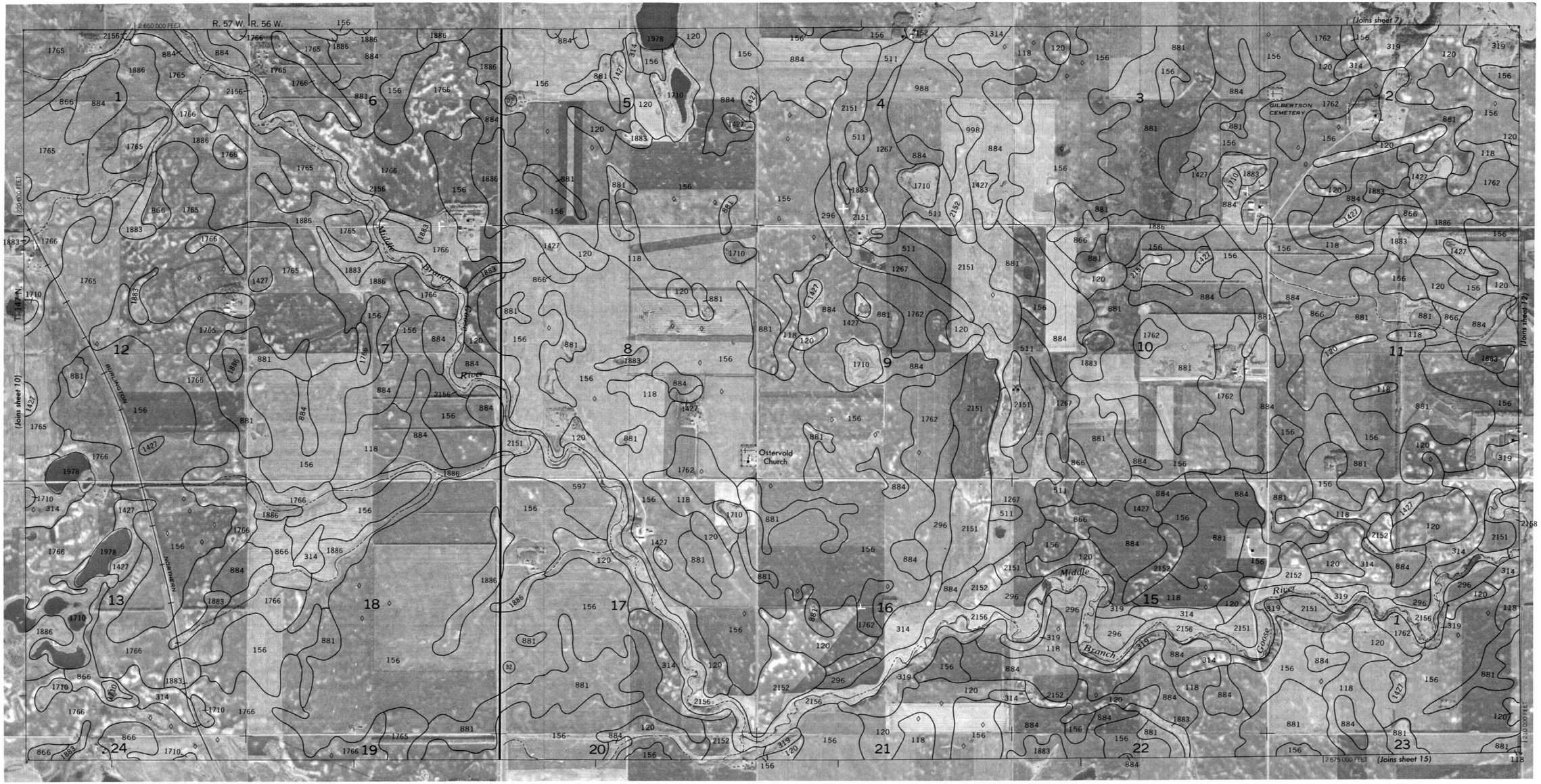
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 10

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981–1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



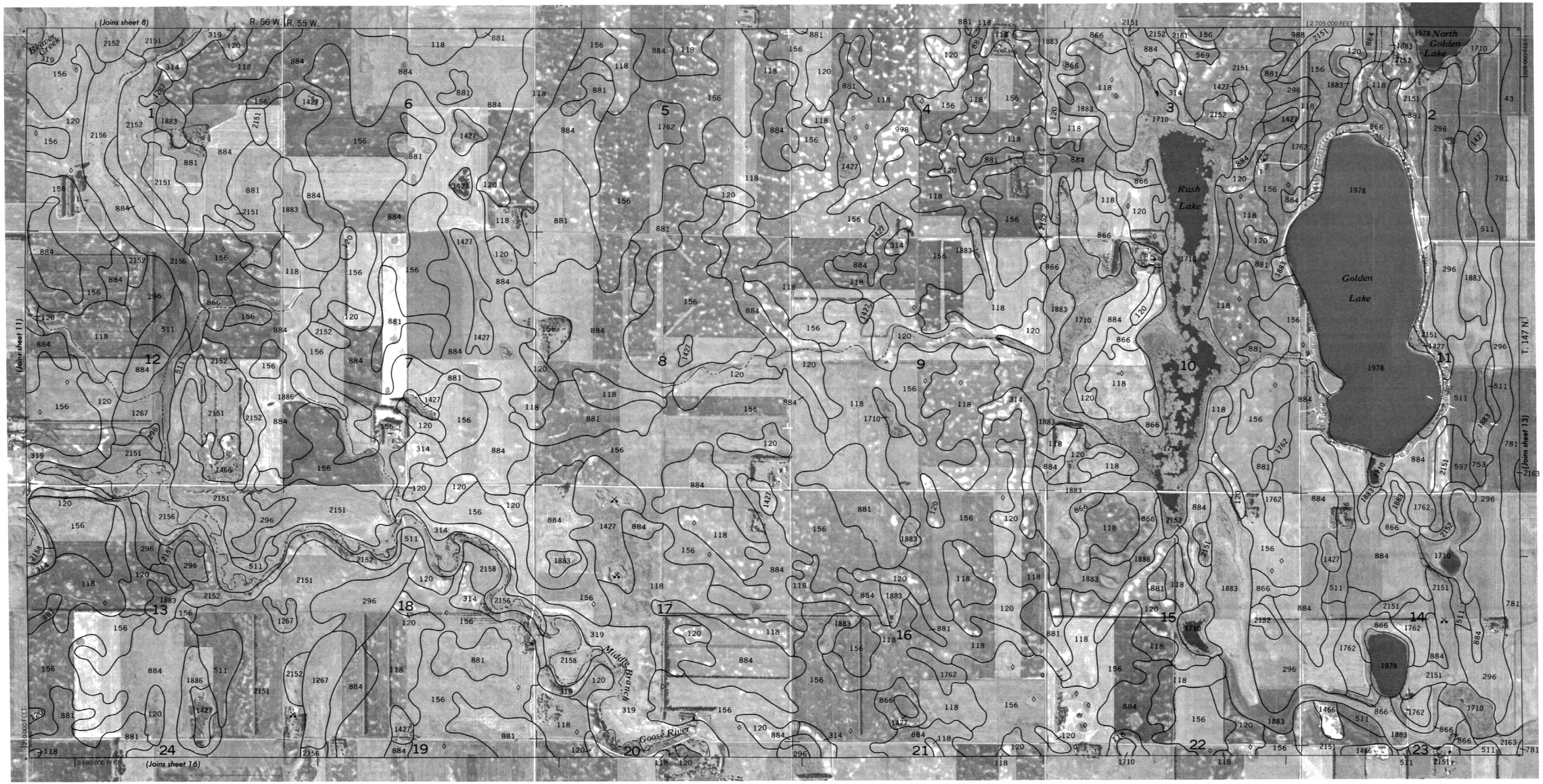
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 11

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

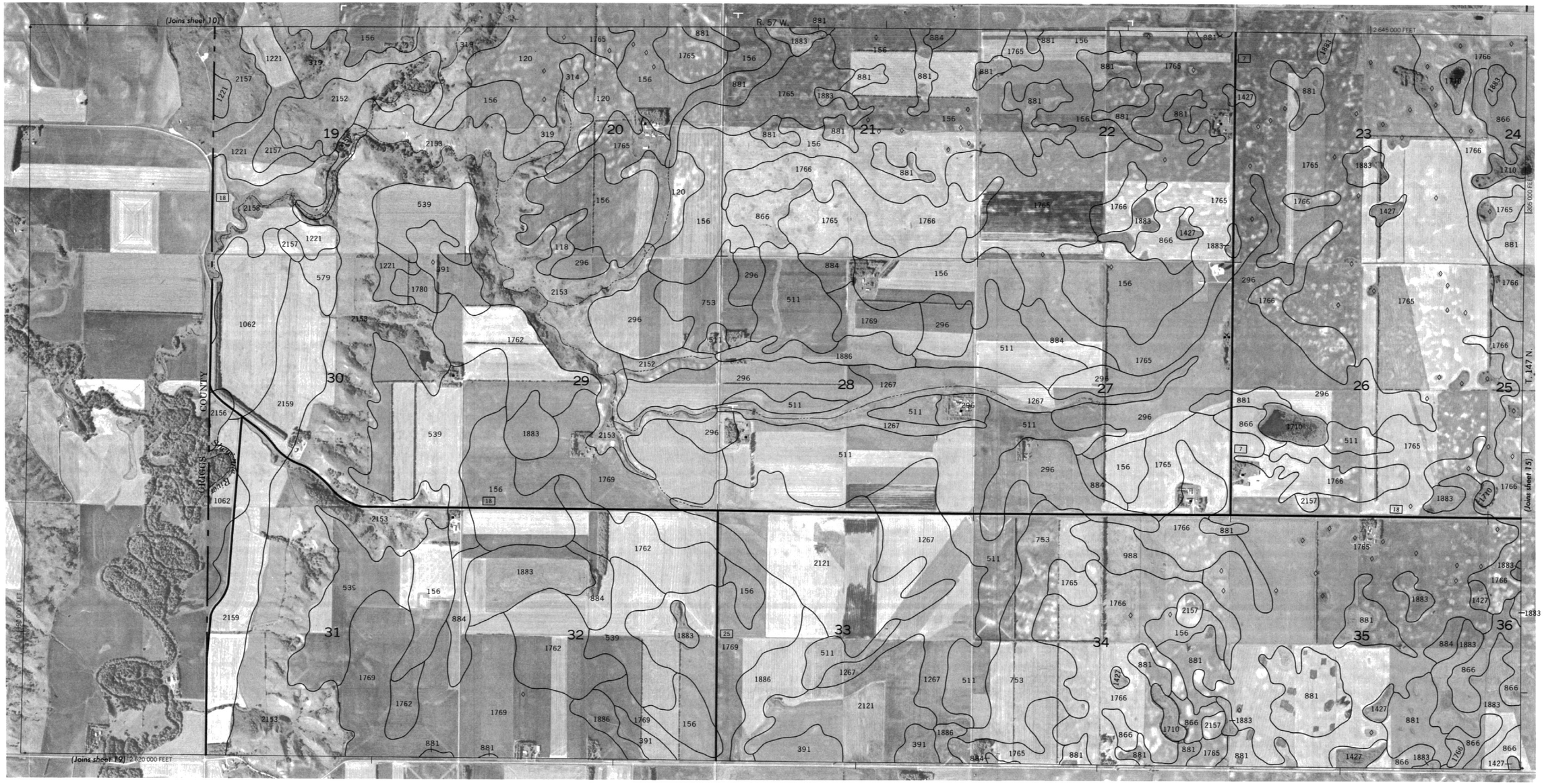
SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 12

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 13

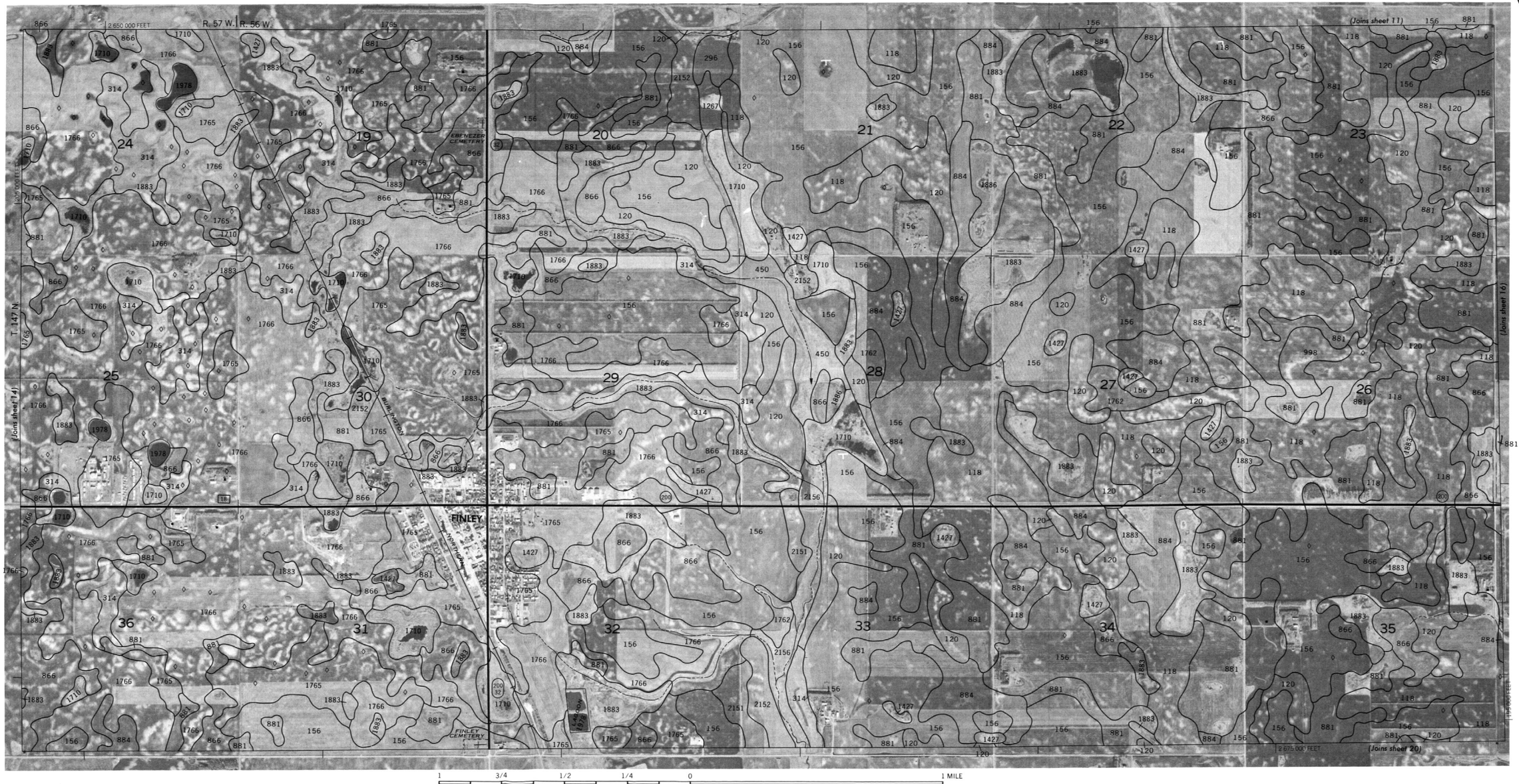
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



STEELE COUNTY, NORTH DAKOTA NO. 14

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981–1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

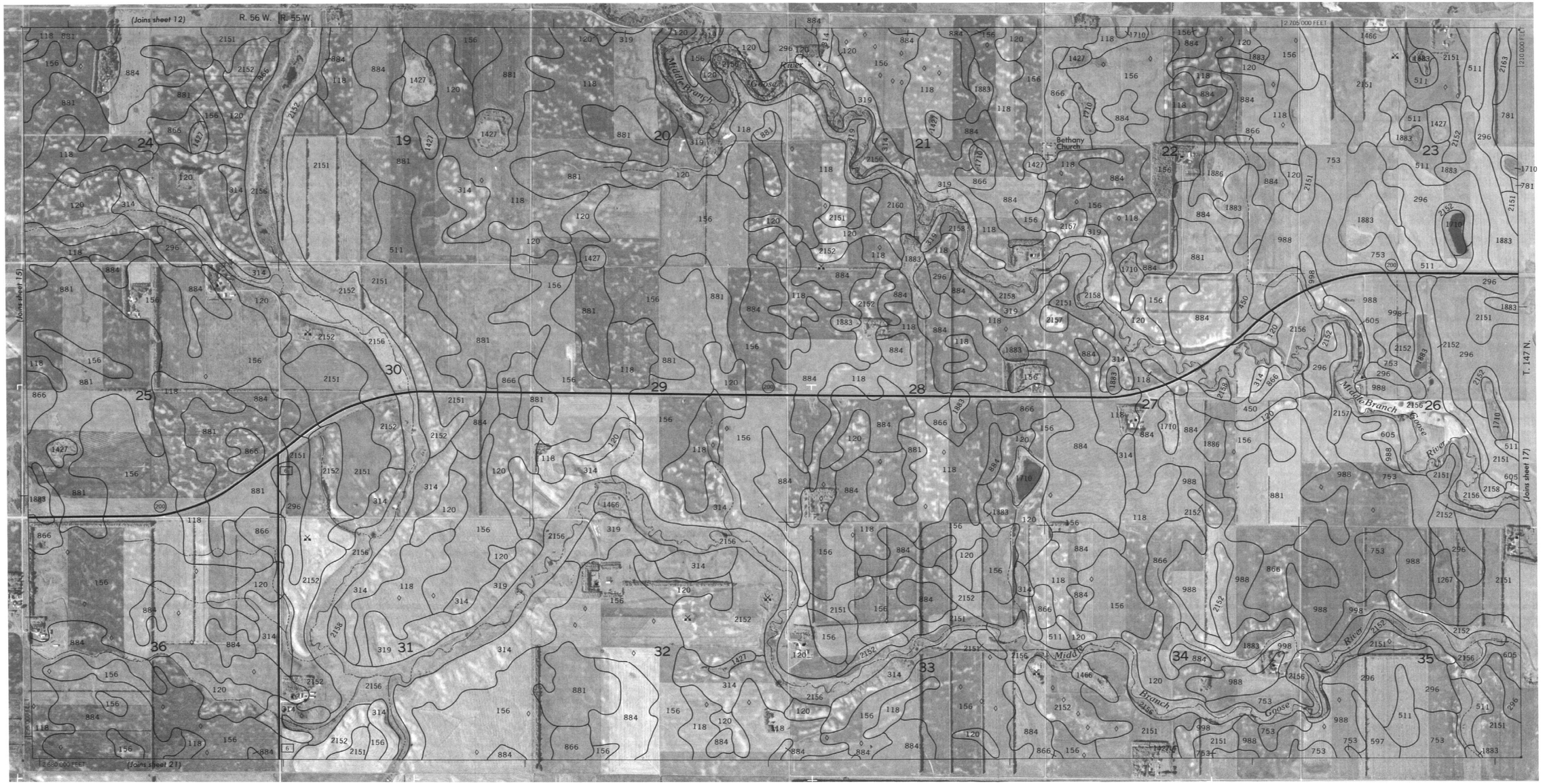
SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 15

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1961 1:62 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

16

N



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 16

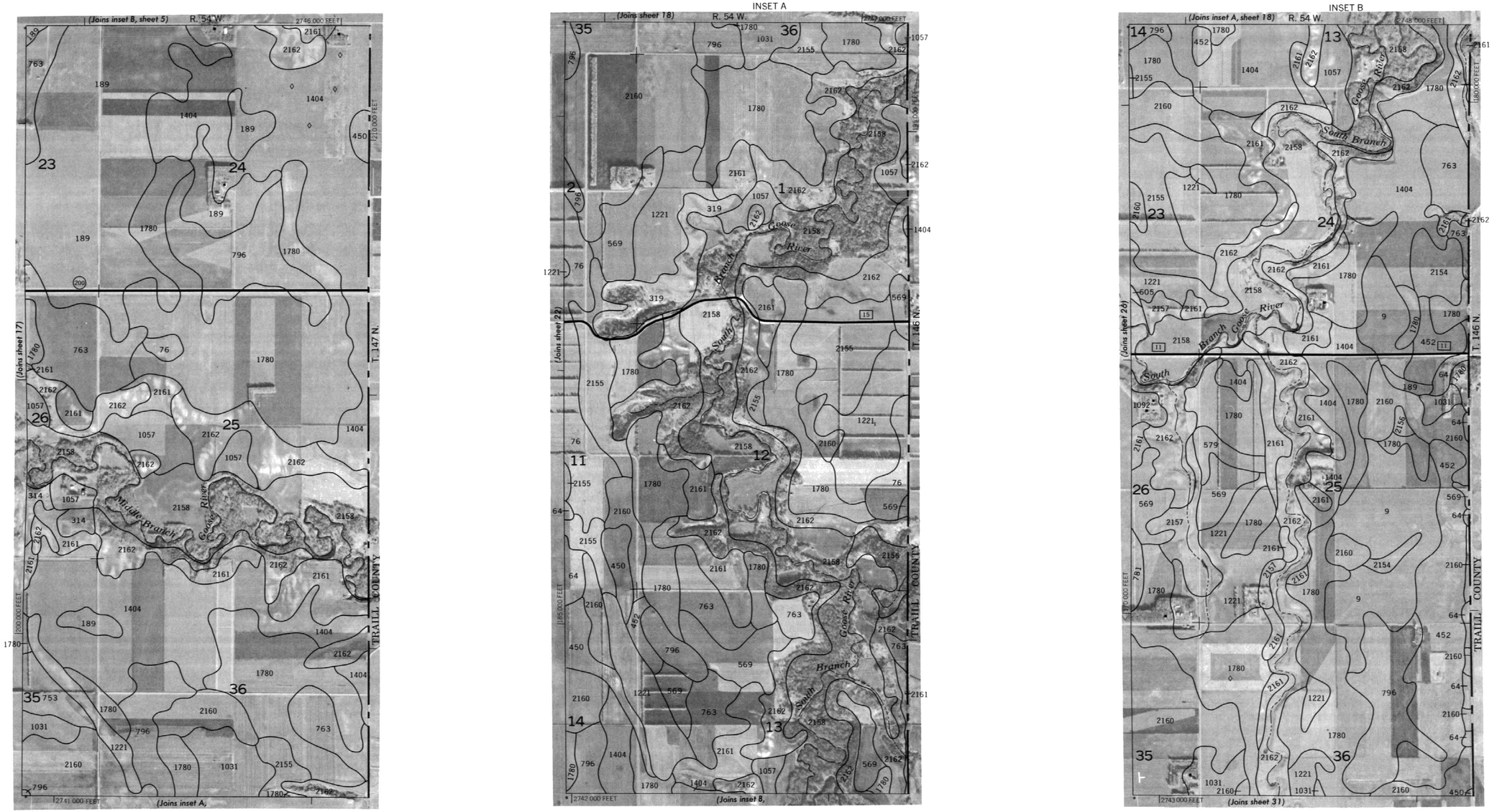
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 17

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

INSET A



1000 AND 5000-FOOT GRID TICKS

2000 AND 5000-FOOT GRID TICKS

INSET B

3000 AND 5000-FOOT GRID TICKS

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 18

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Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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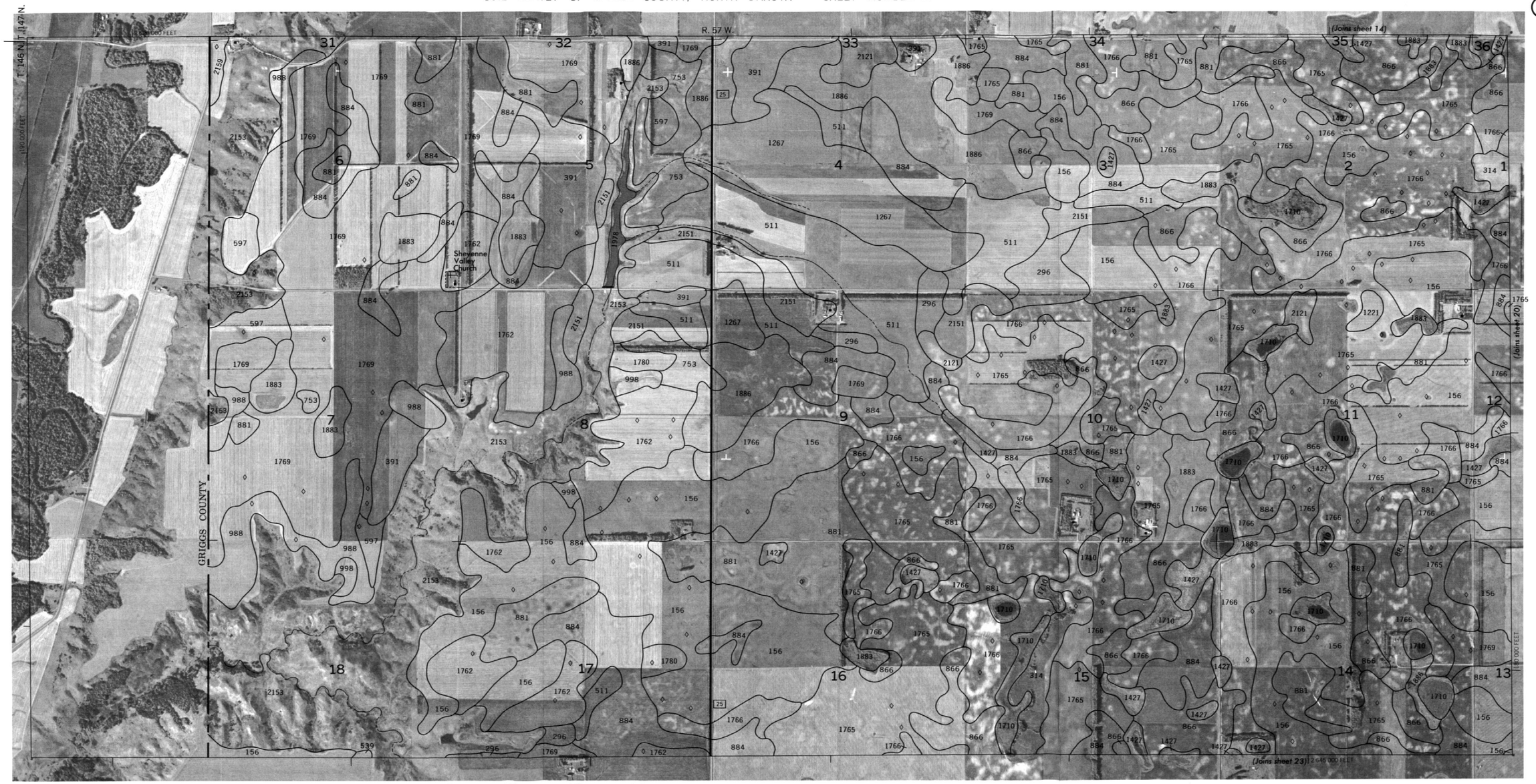
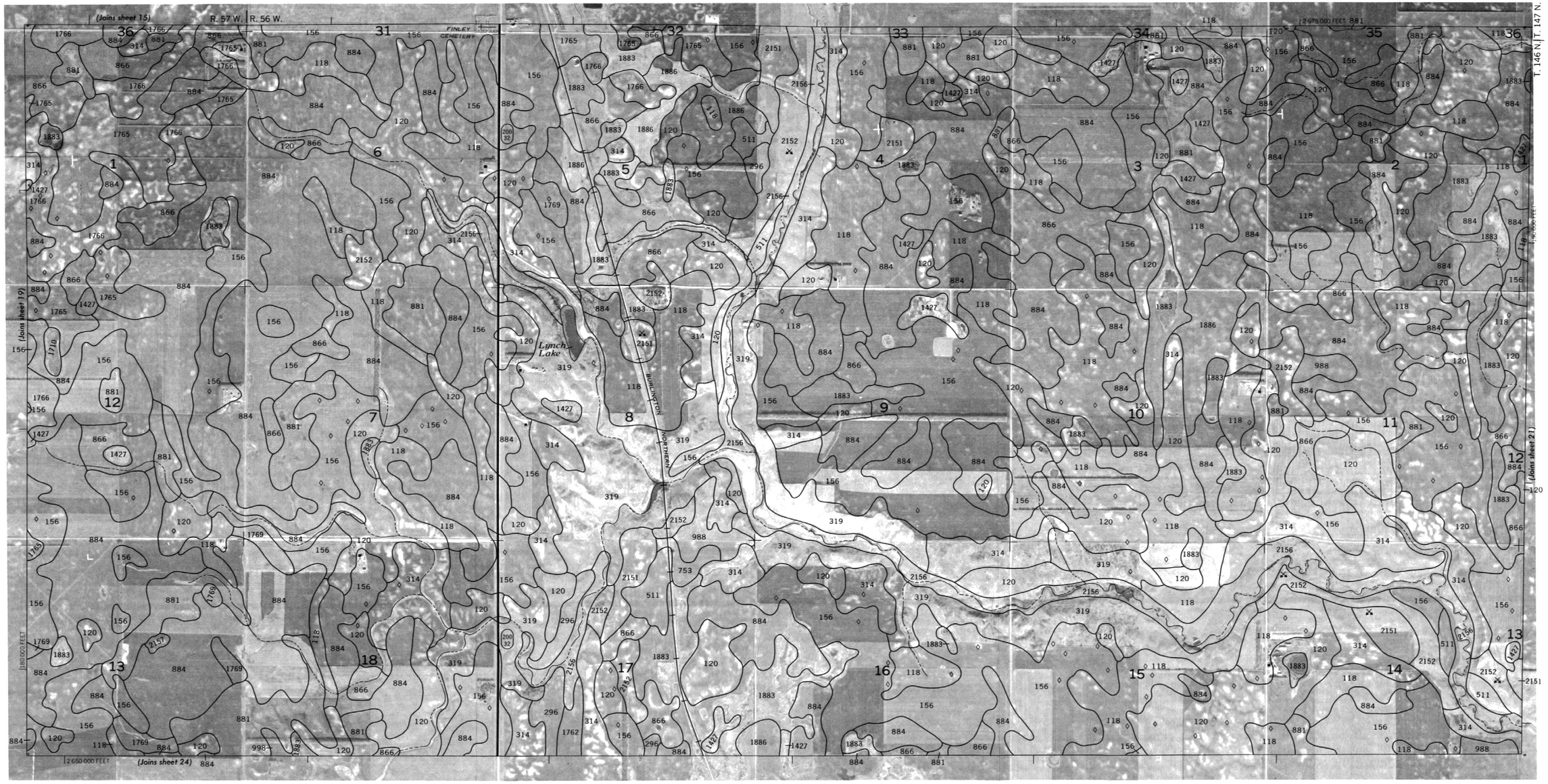
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 19

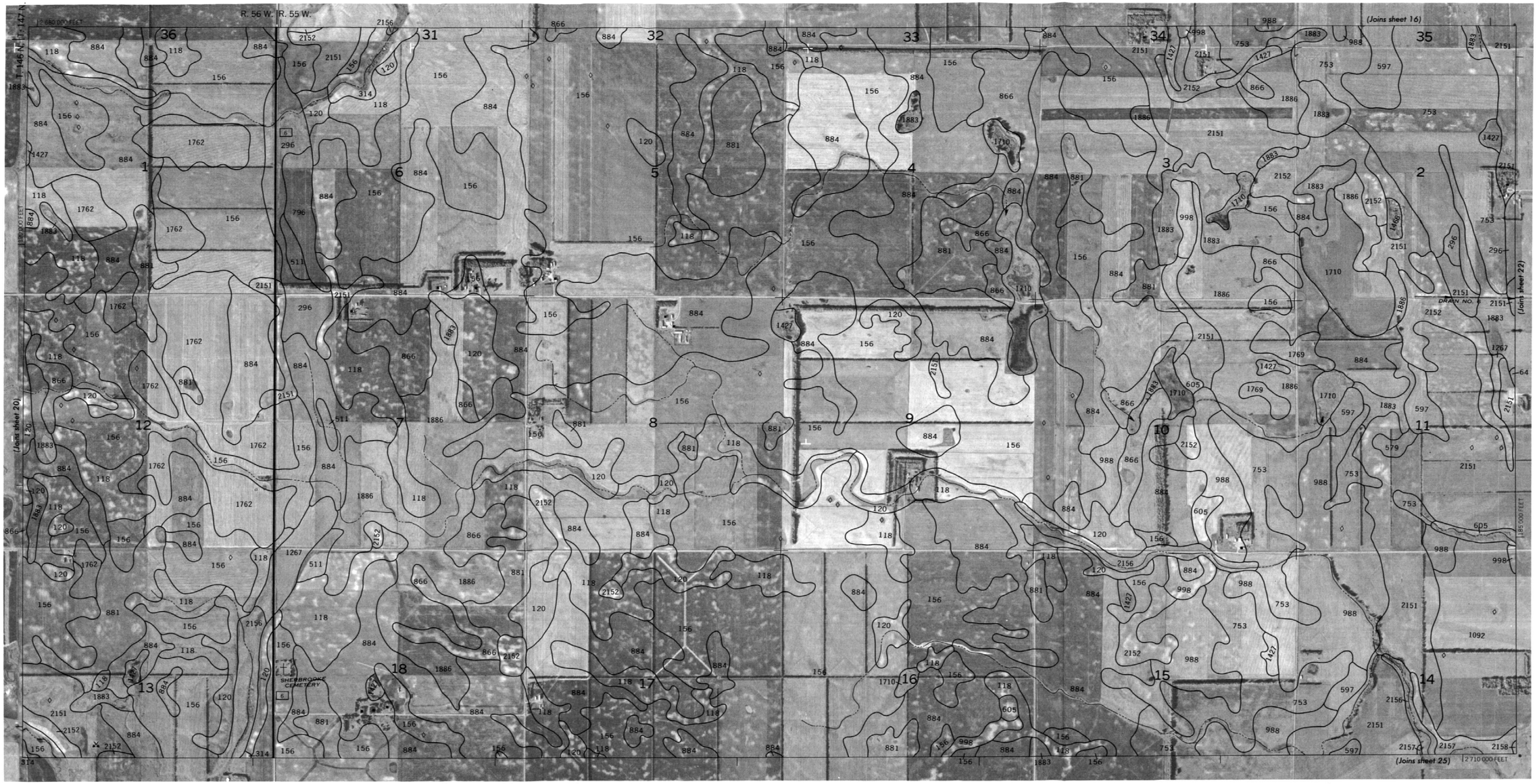




STEELE COUNTY, NORTH DAKOTA NO. 20

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 21

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

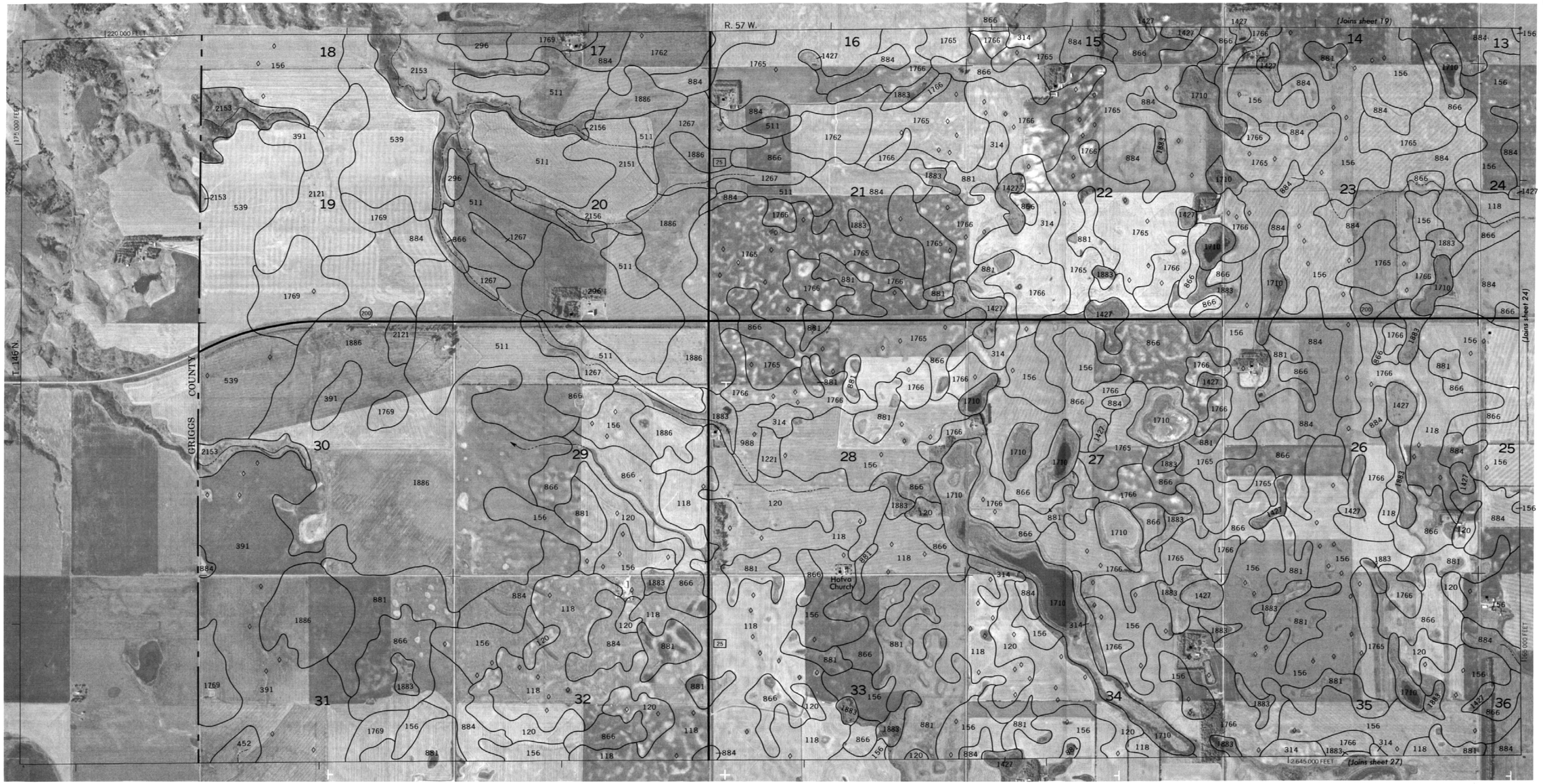
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 22

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned



N

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 23

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

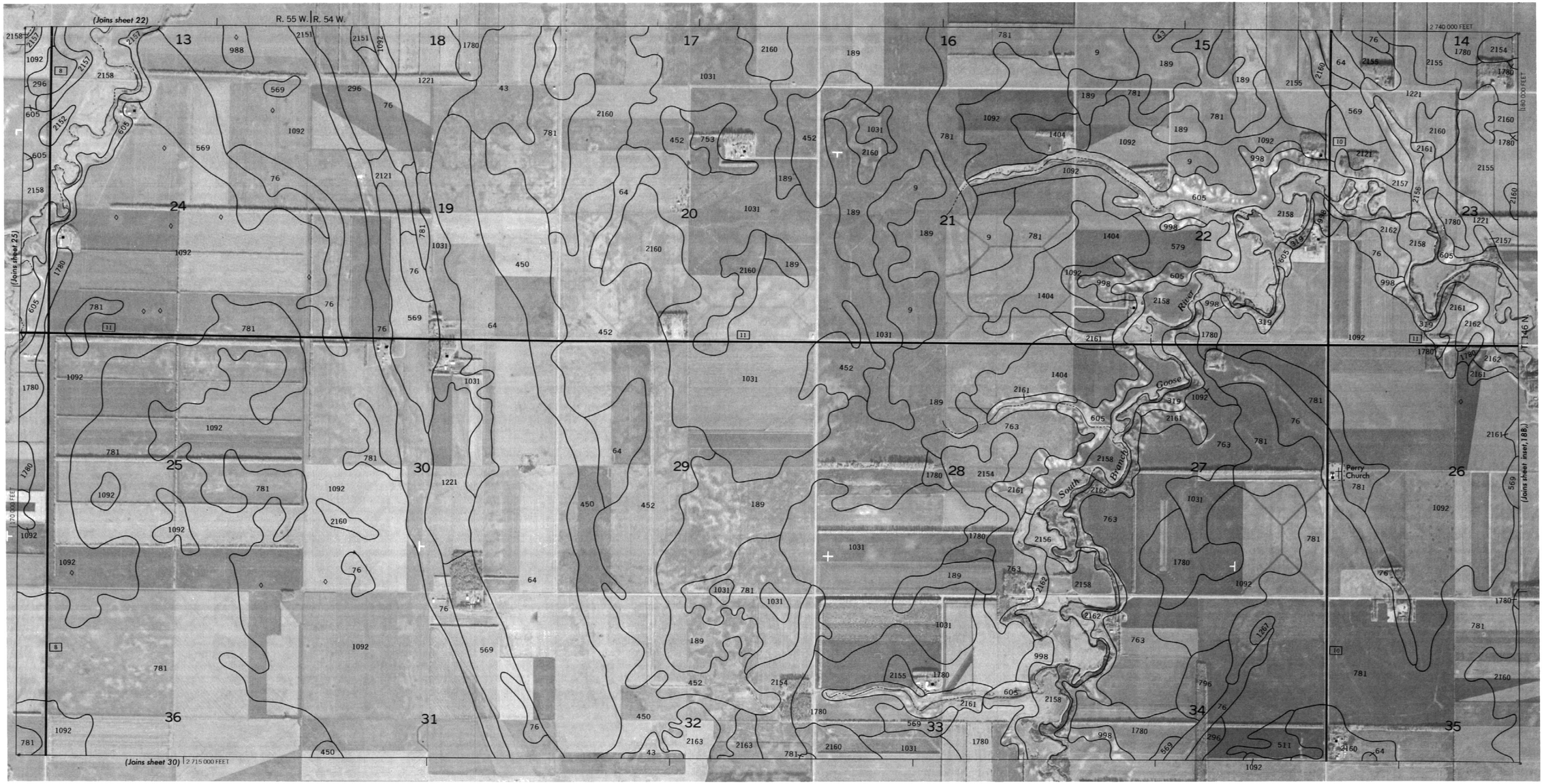
SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 24

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 25

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



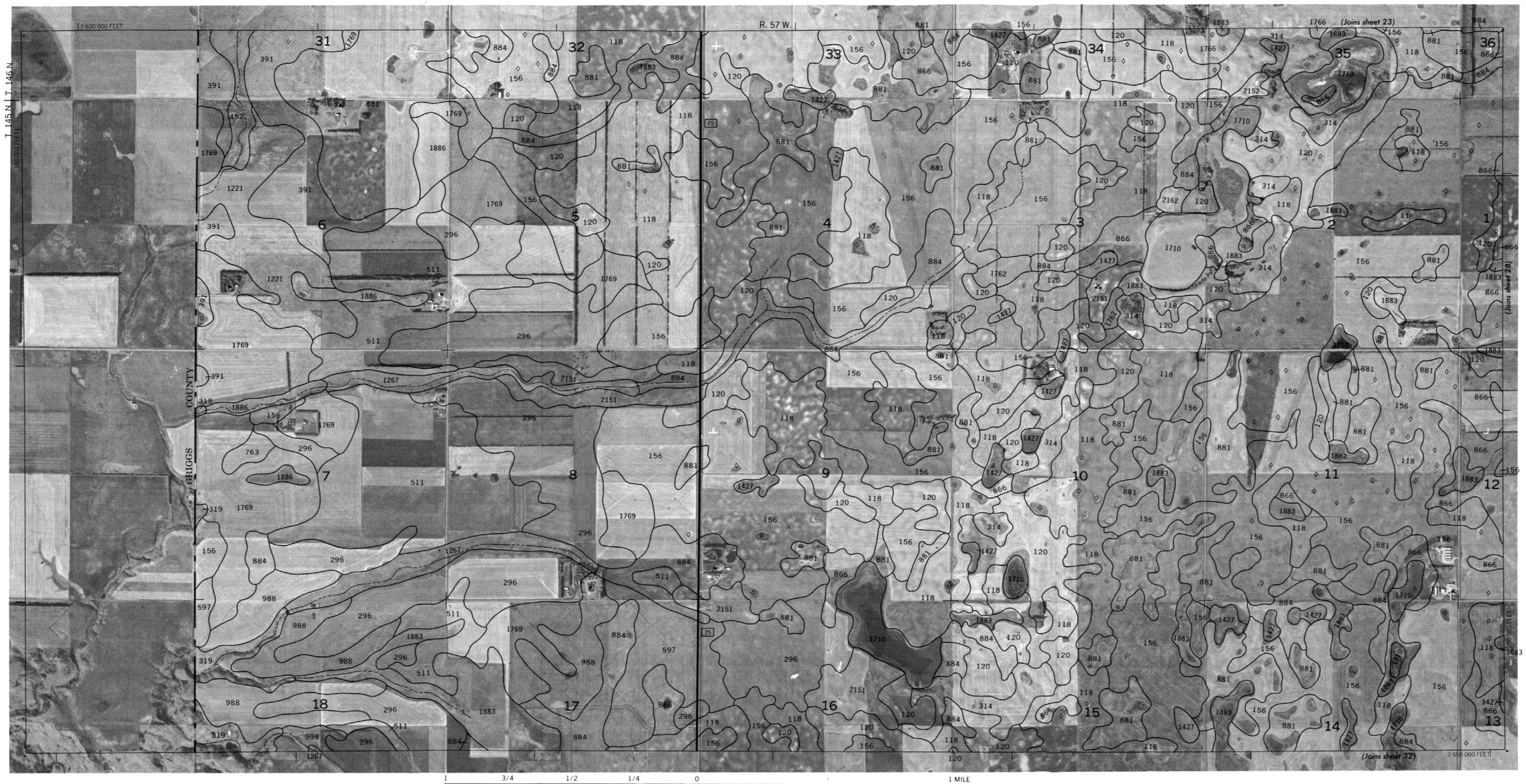
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 26

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 27

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

28

N

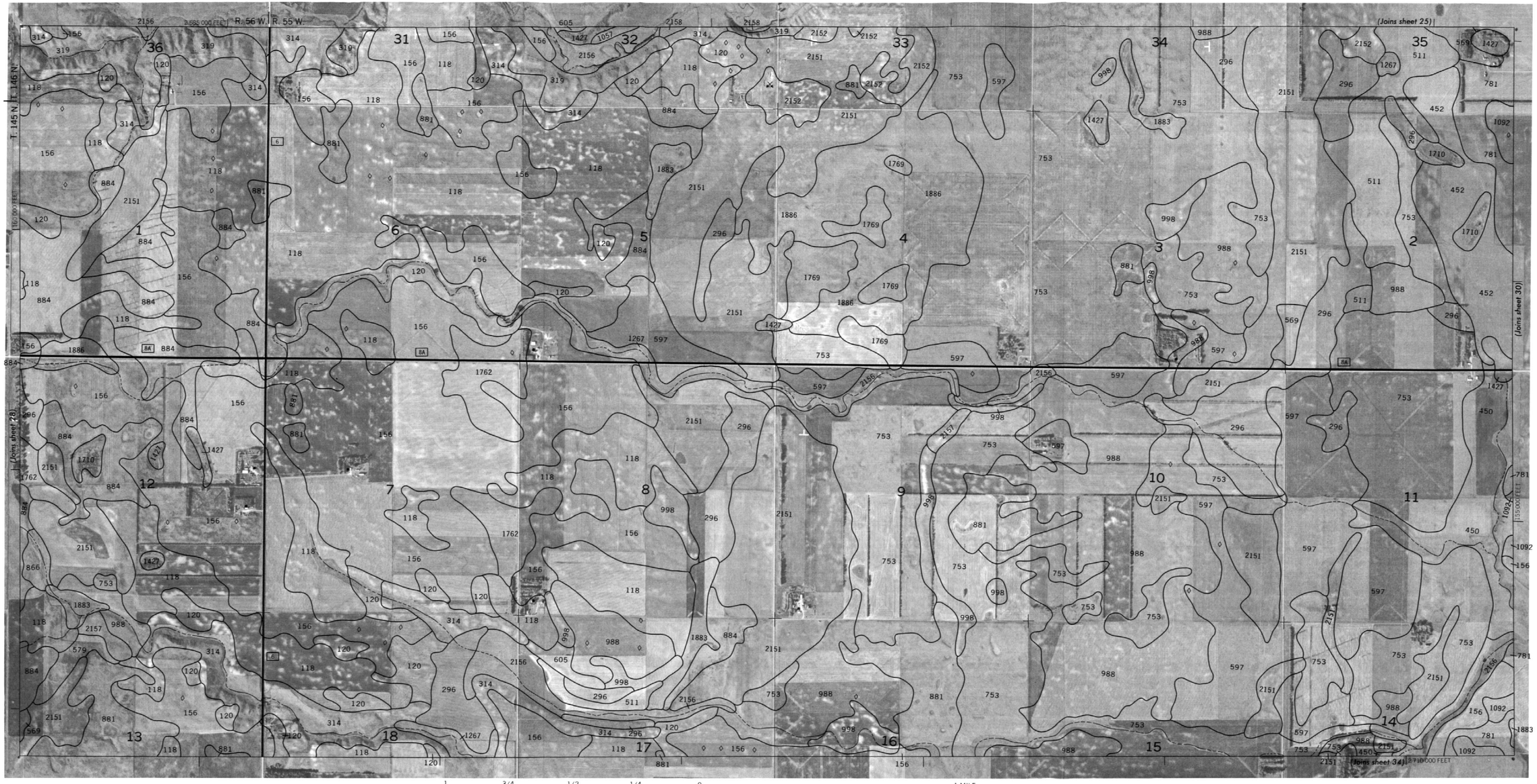
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 28

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned



This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 29

1 3/4 1/2 1/4 0 1 MILE

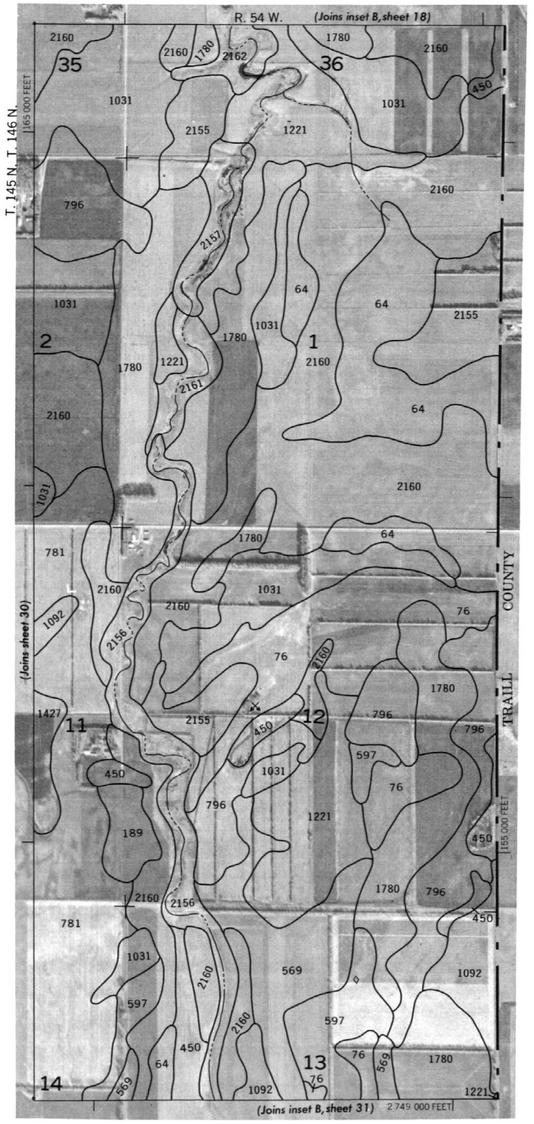
1 0.5 0 1 KILOMETER

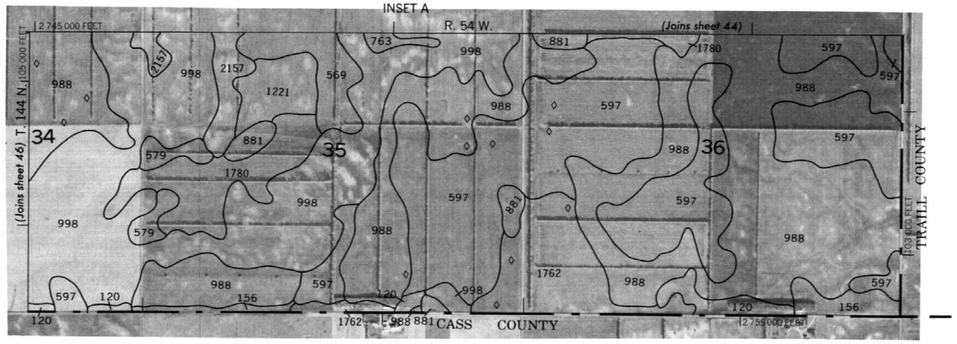
SCALE 1:20 000

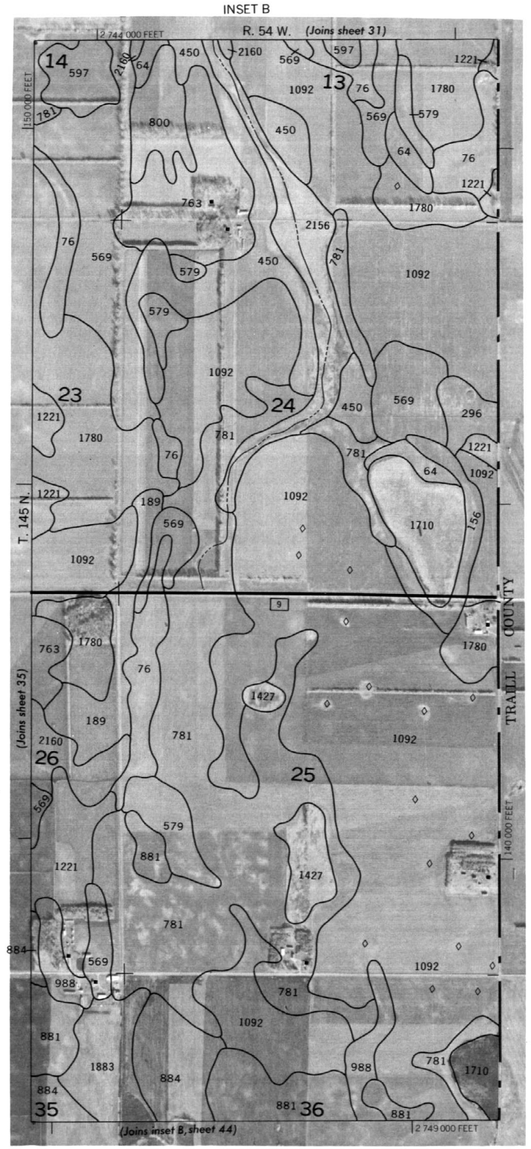
STEELE COUNTY, NORTH DAKOTA NO. 30

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1961 1:962 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N







1 3/4 1/2 1/4 0 1 MILE

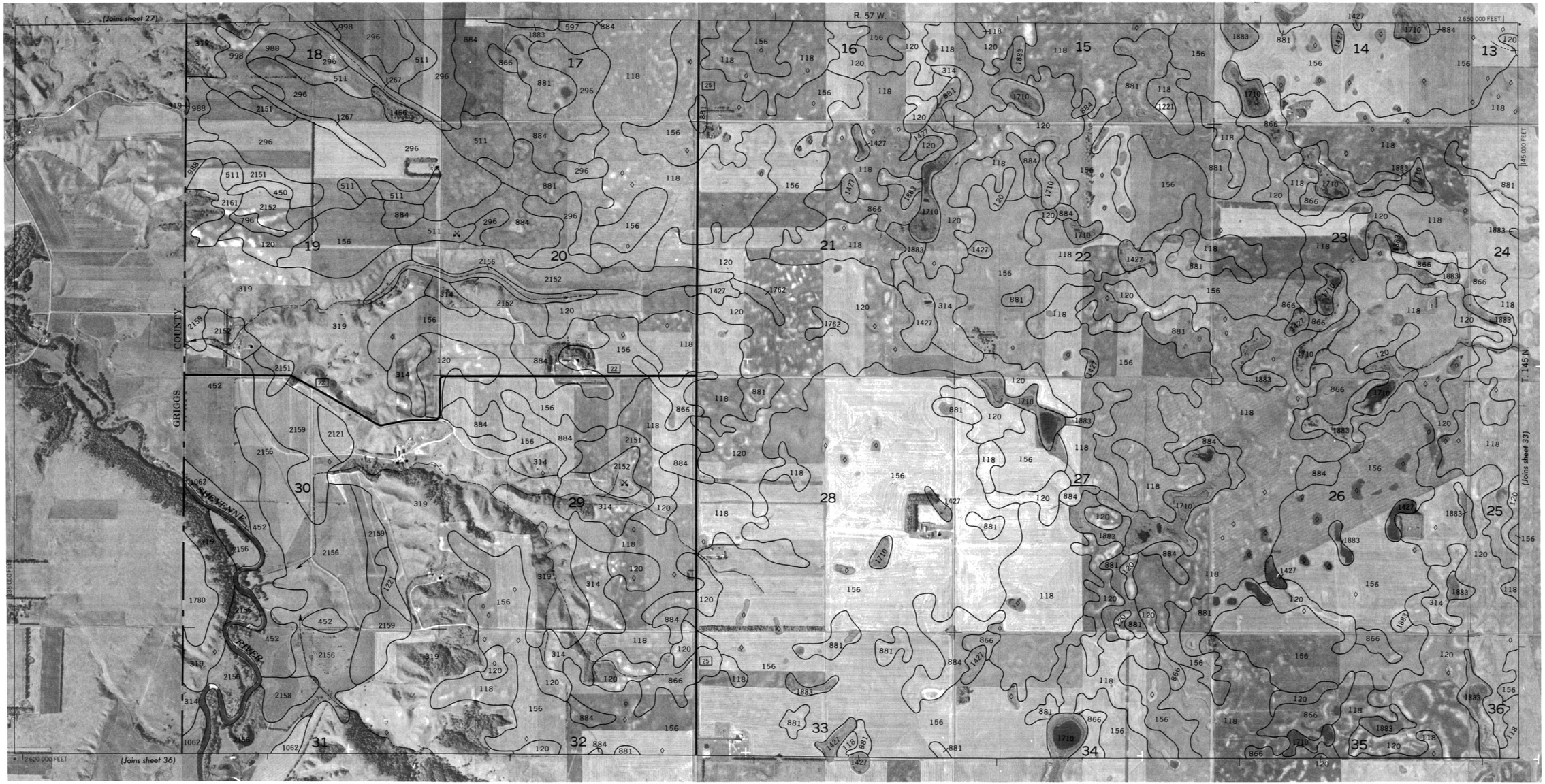
1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 31

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N



1 3/4 1/2 1/4 0 1 MILE

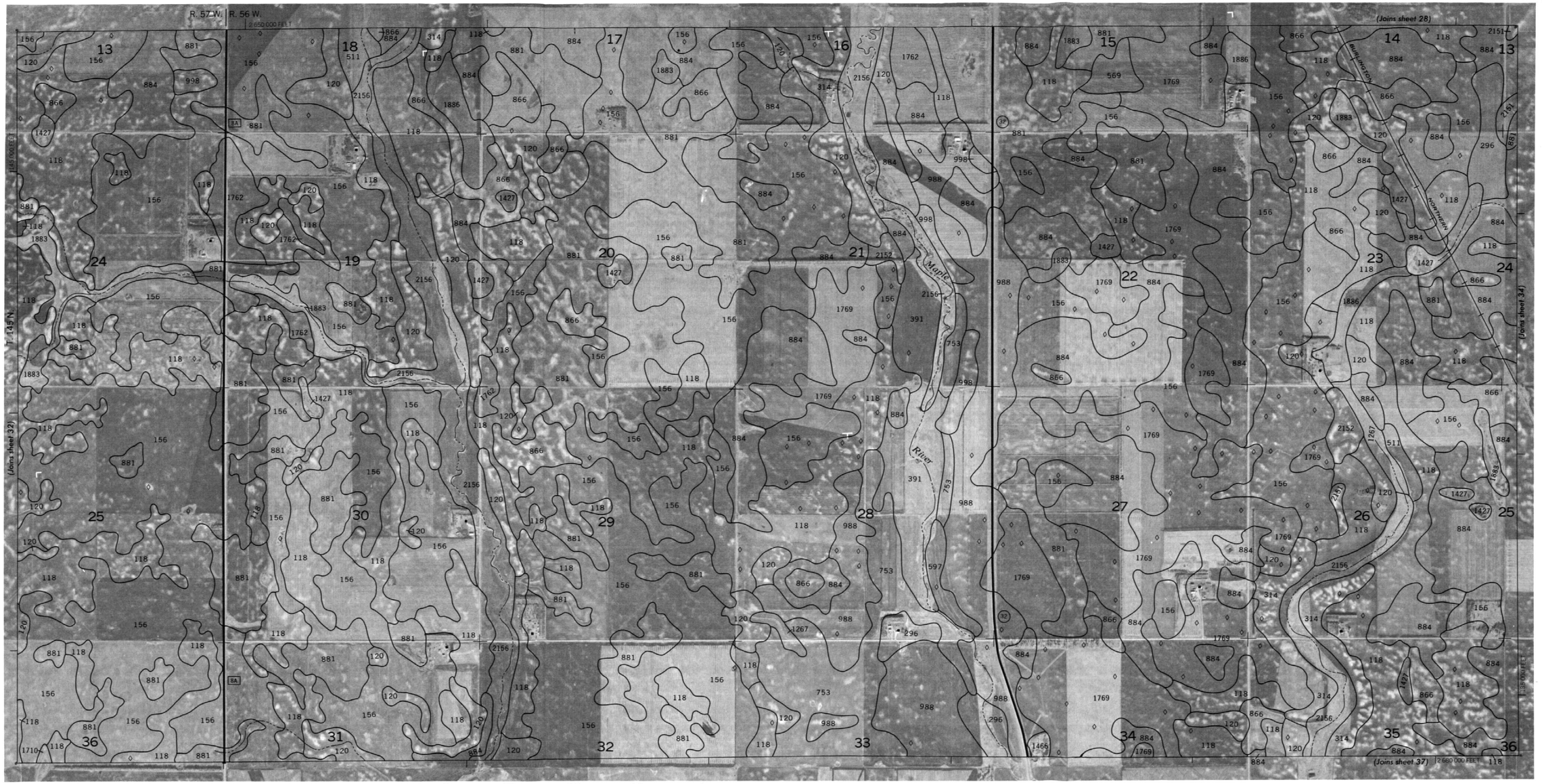
1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 32

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N



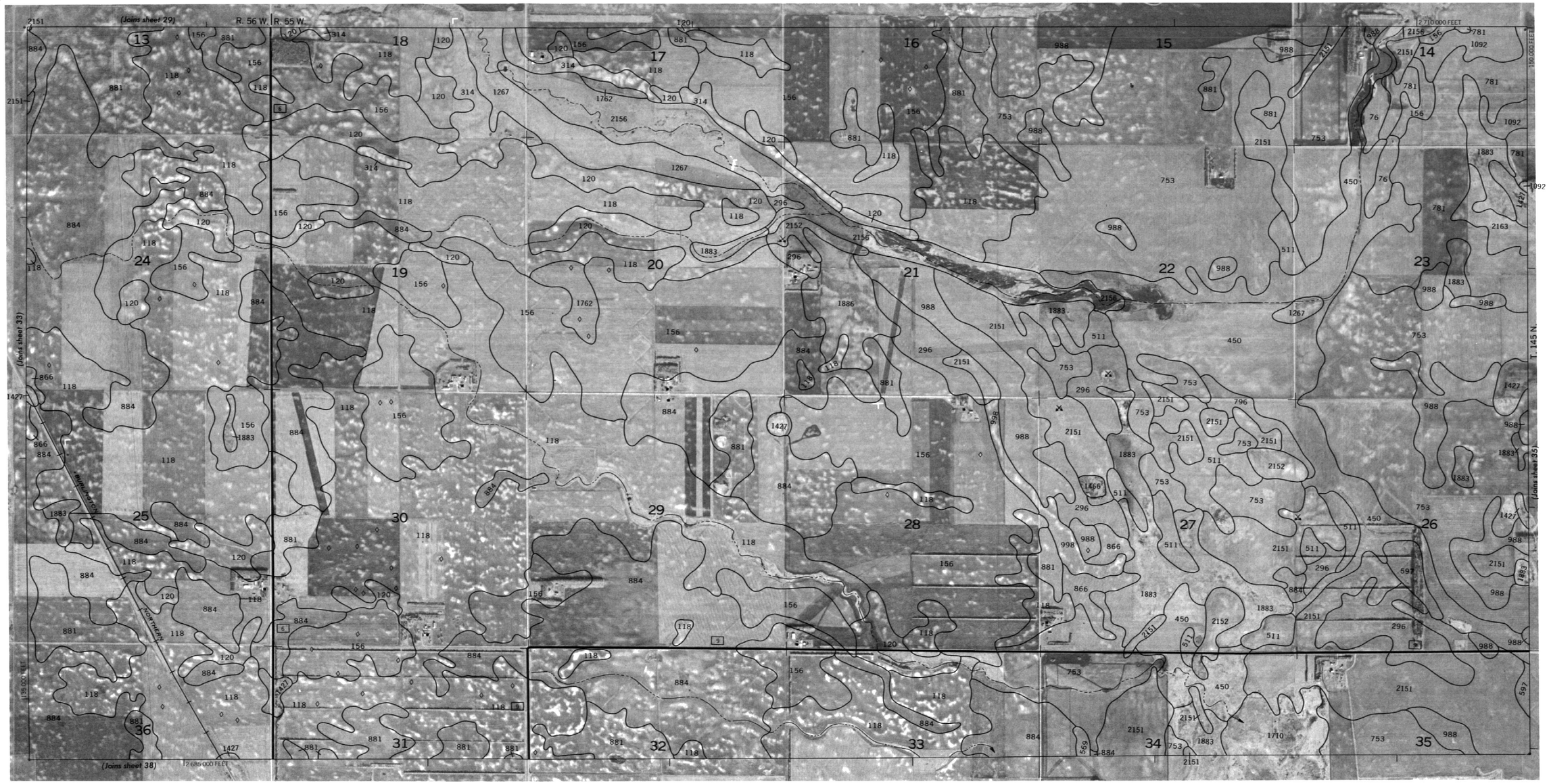
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 33

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1961-1962 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 3/4 1/2 1/4 0 1 MILE

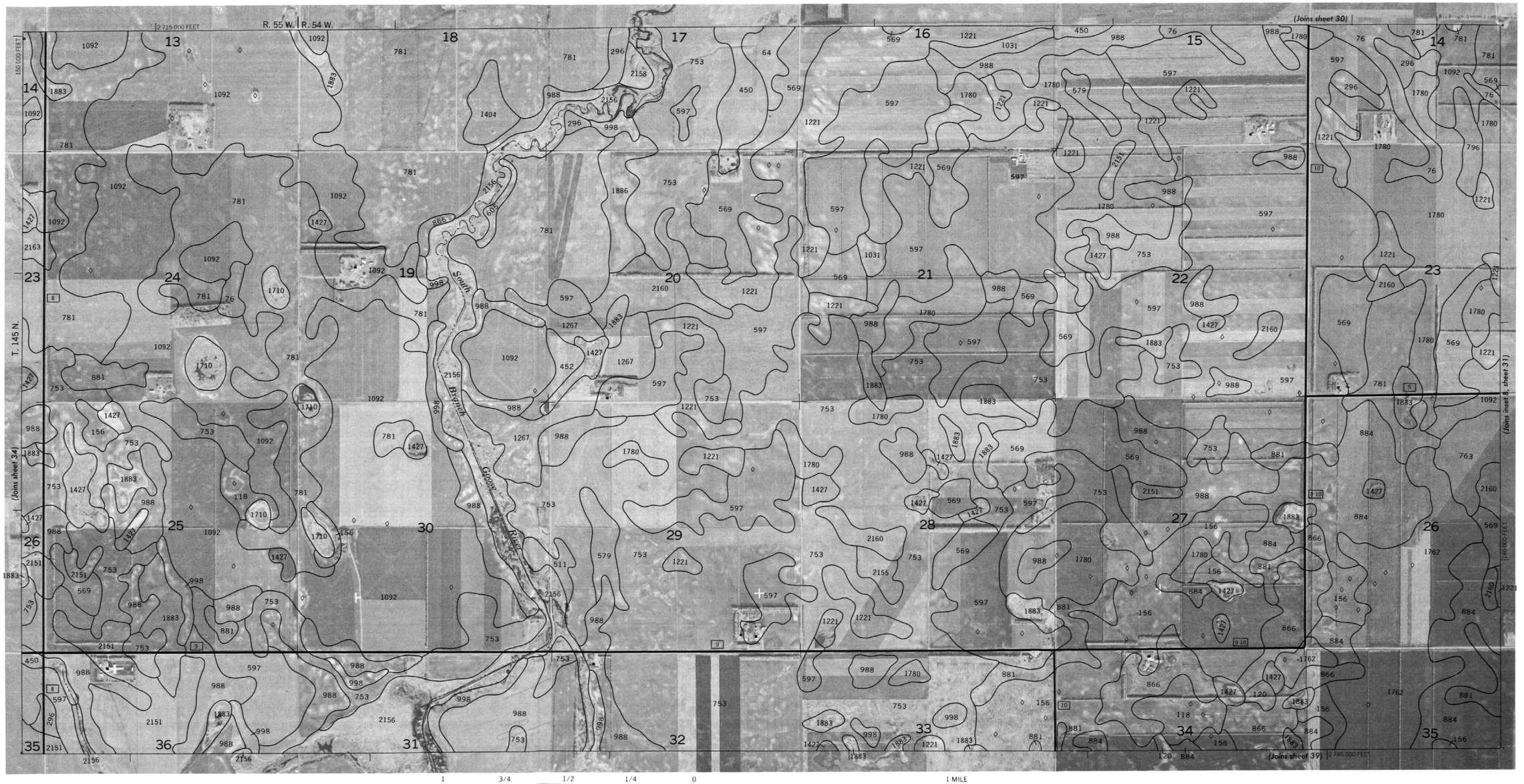
1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 34

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N



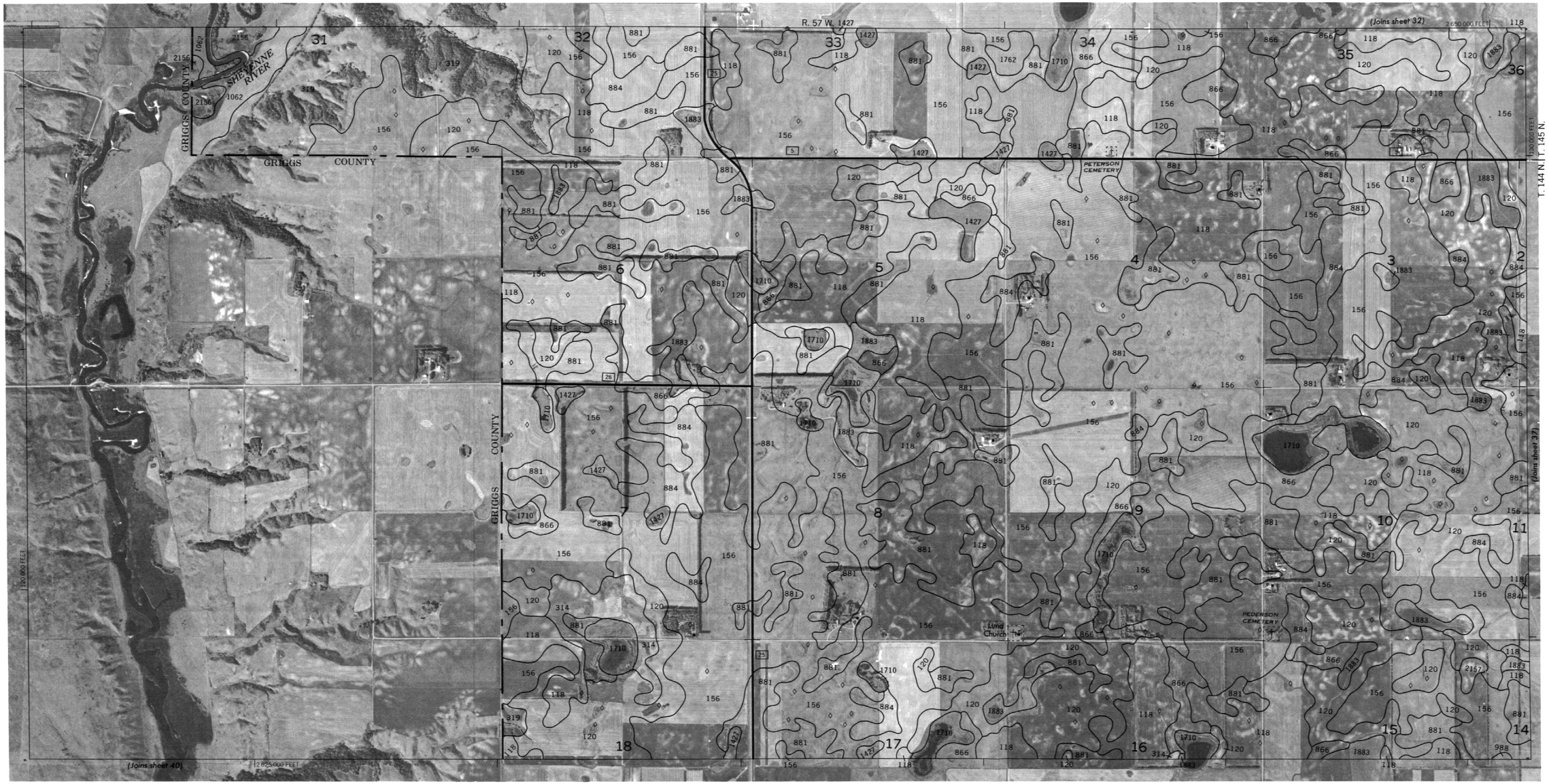
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

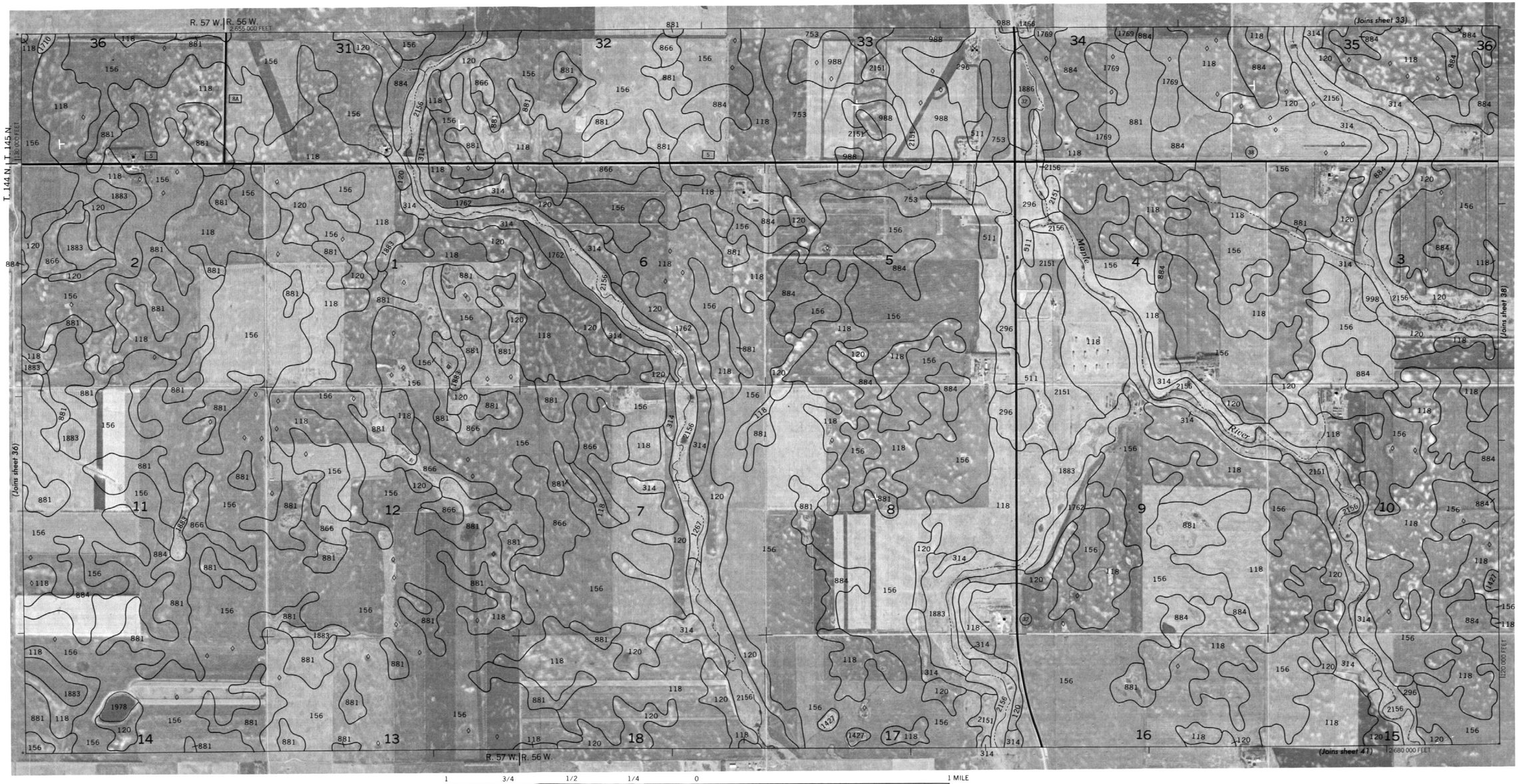
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 35



STEELE COUNTY, NORTH DAKOTA NO. 36

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

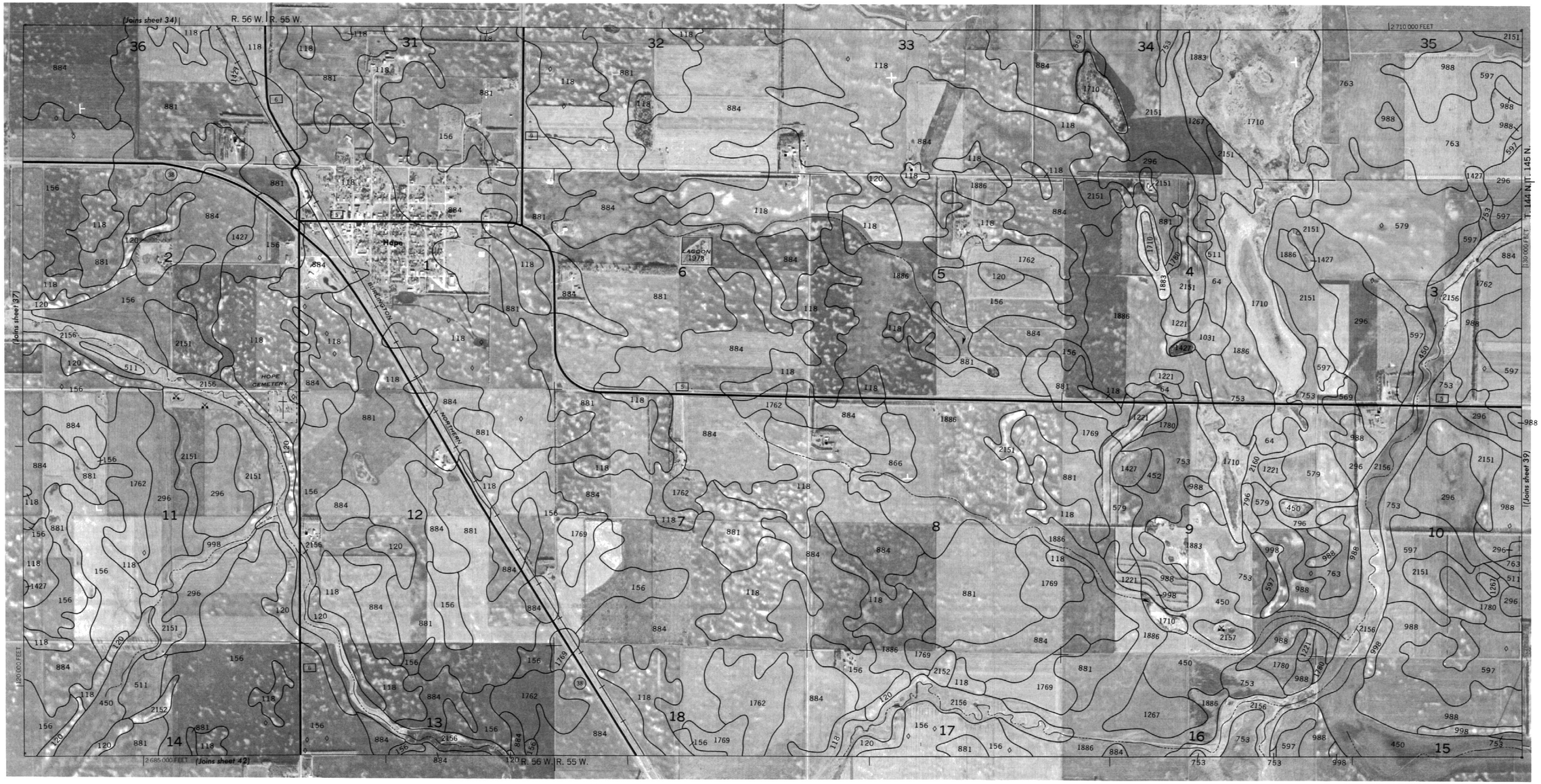


This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEELE COUNTY, NORTH DAKOTA NO. 37

1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

SOIL SURVEY OF STEELE COUNTY, NORTH DAKOTA — SHEET NUMBER 38



1 3/4 1/2 1/4 0 1 MILE

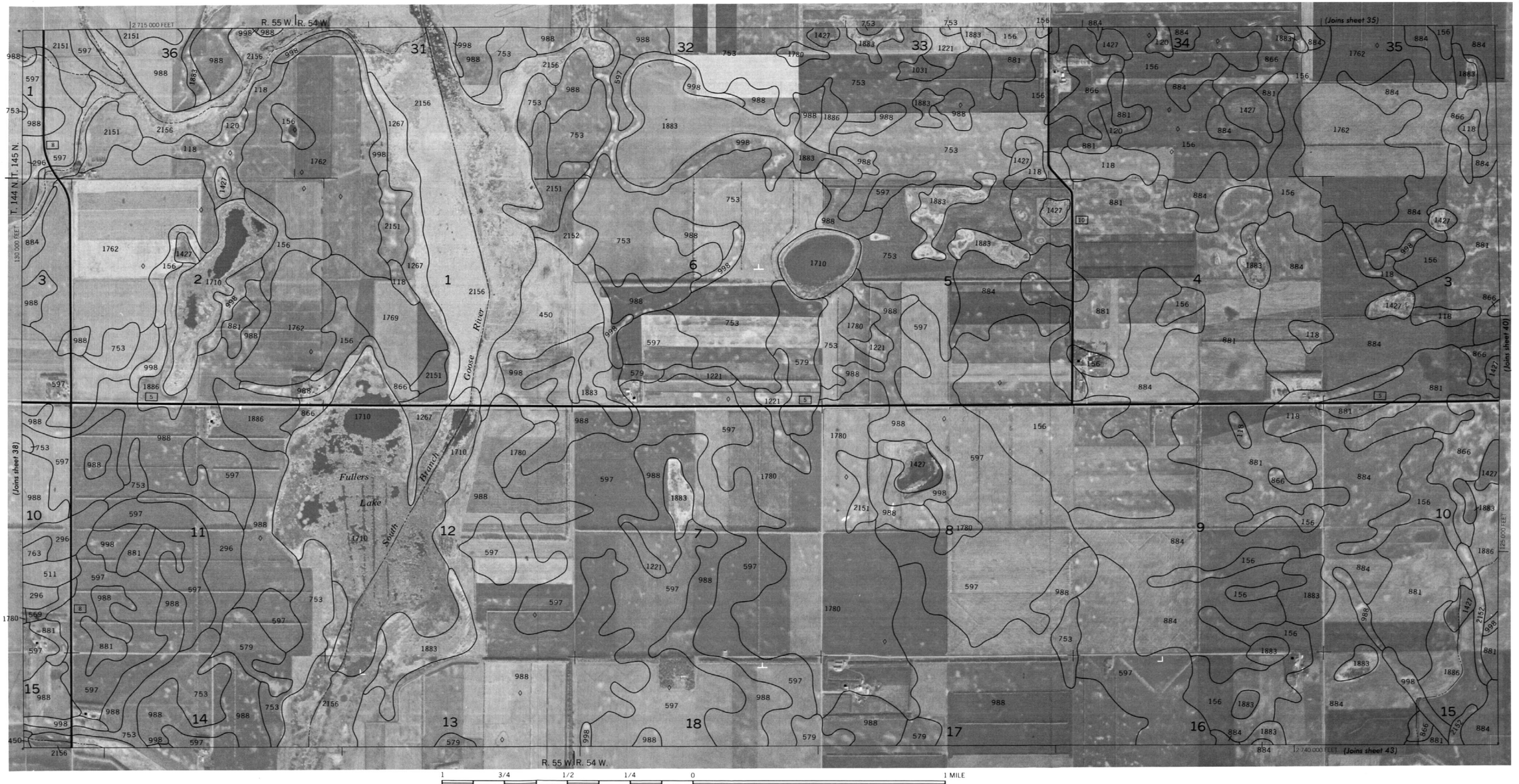
1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 38

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

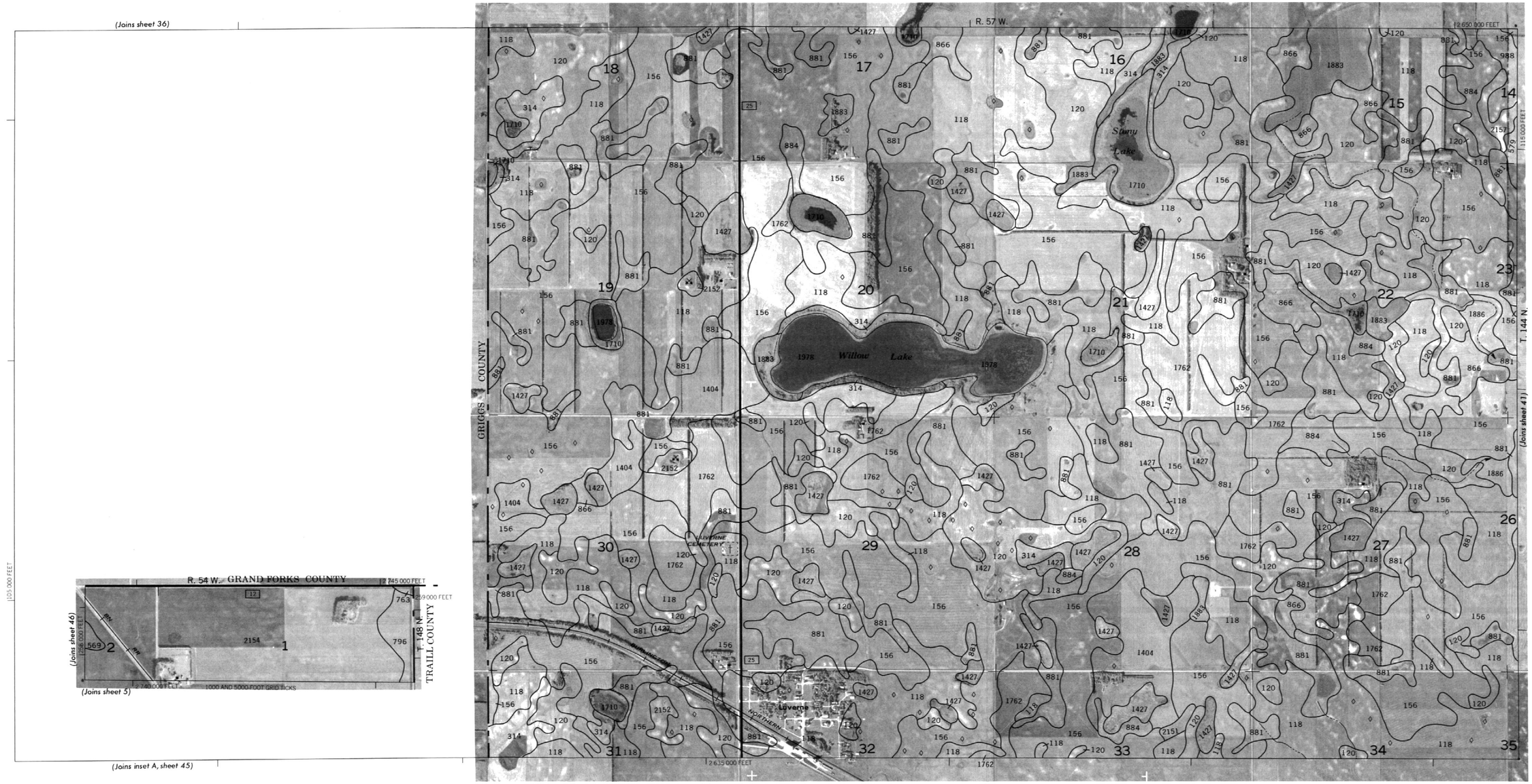


STEELE COUNTY, NORTH DAKOTA NO. 39

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

(Joins sheet 36)



(Joins sheet 41)

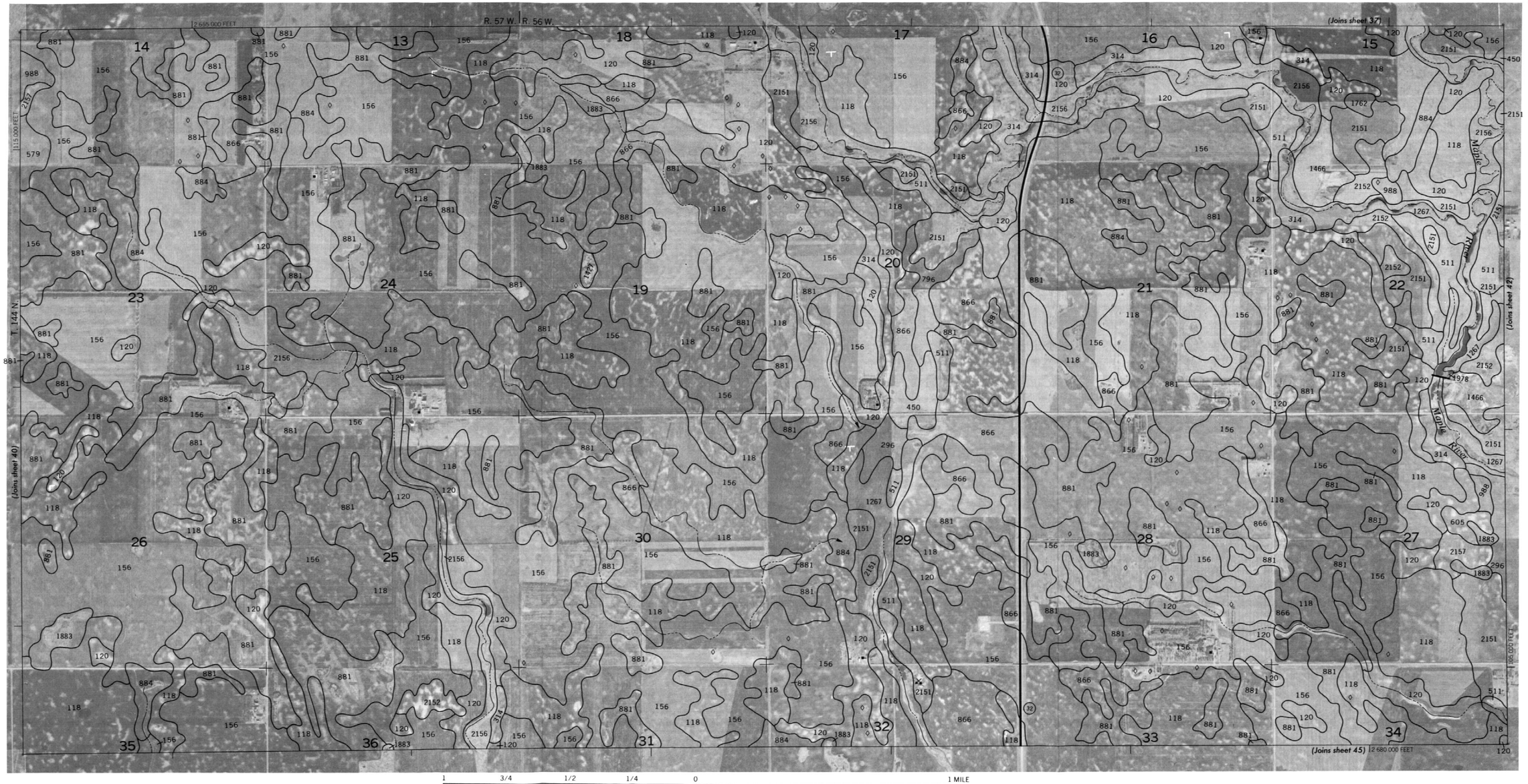
(Joins inset A, sheet 45)

(Joins sheet 46)

(Joins sheet 5)

STEELE COUNTY, NORTH DAKOTA NO. 40

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 3/4 1/2 1/4 0 1 MILE

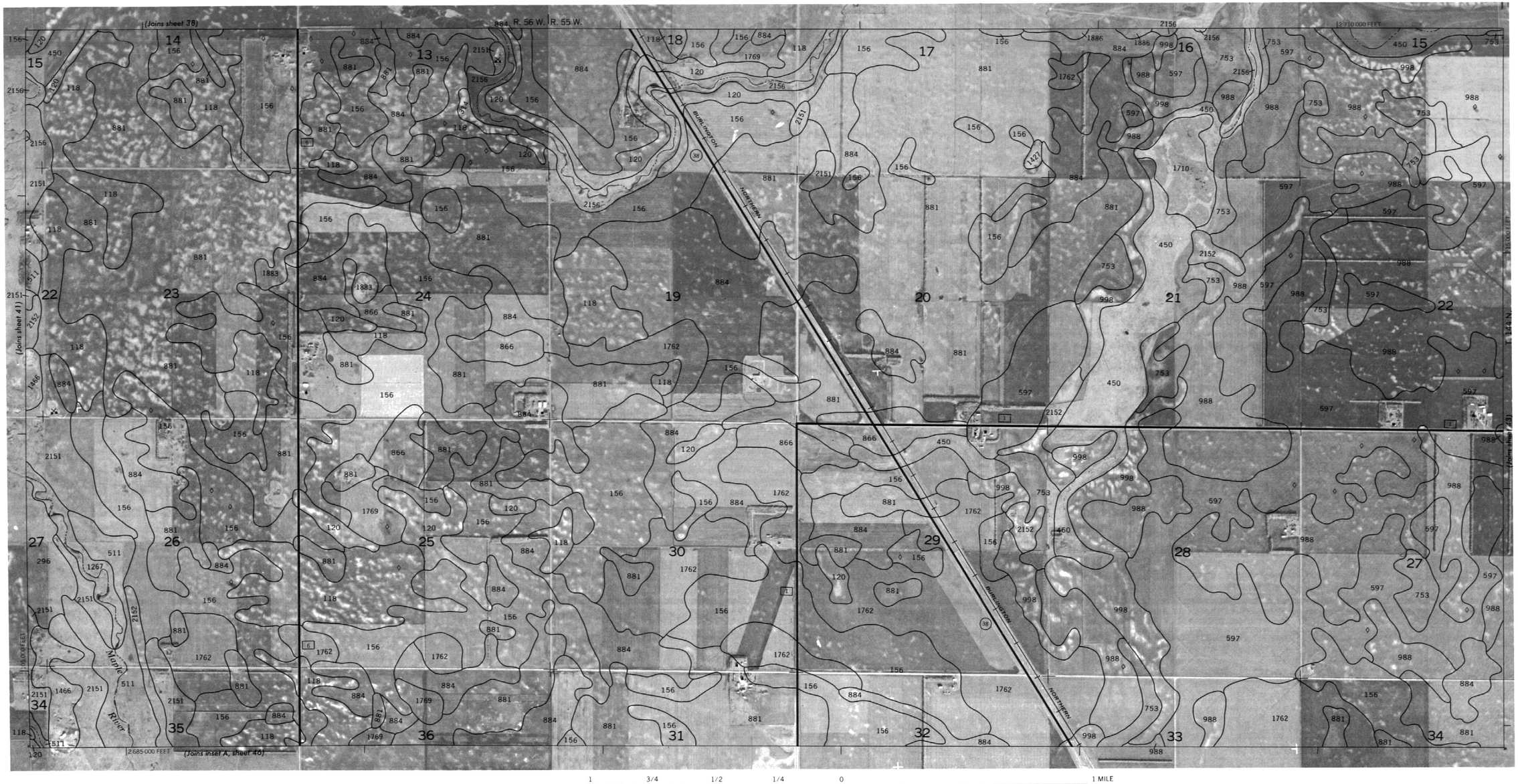
1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 41

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N



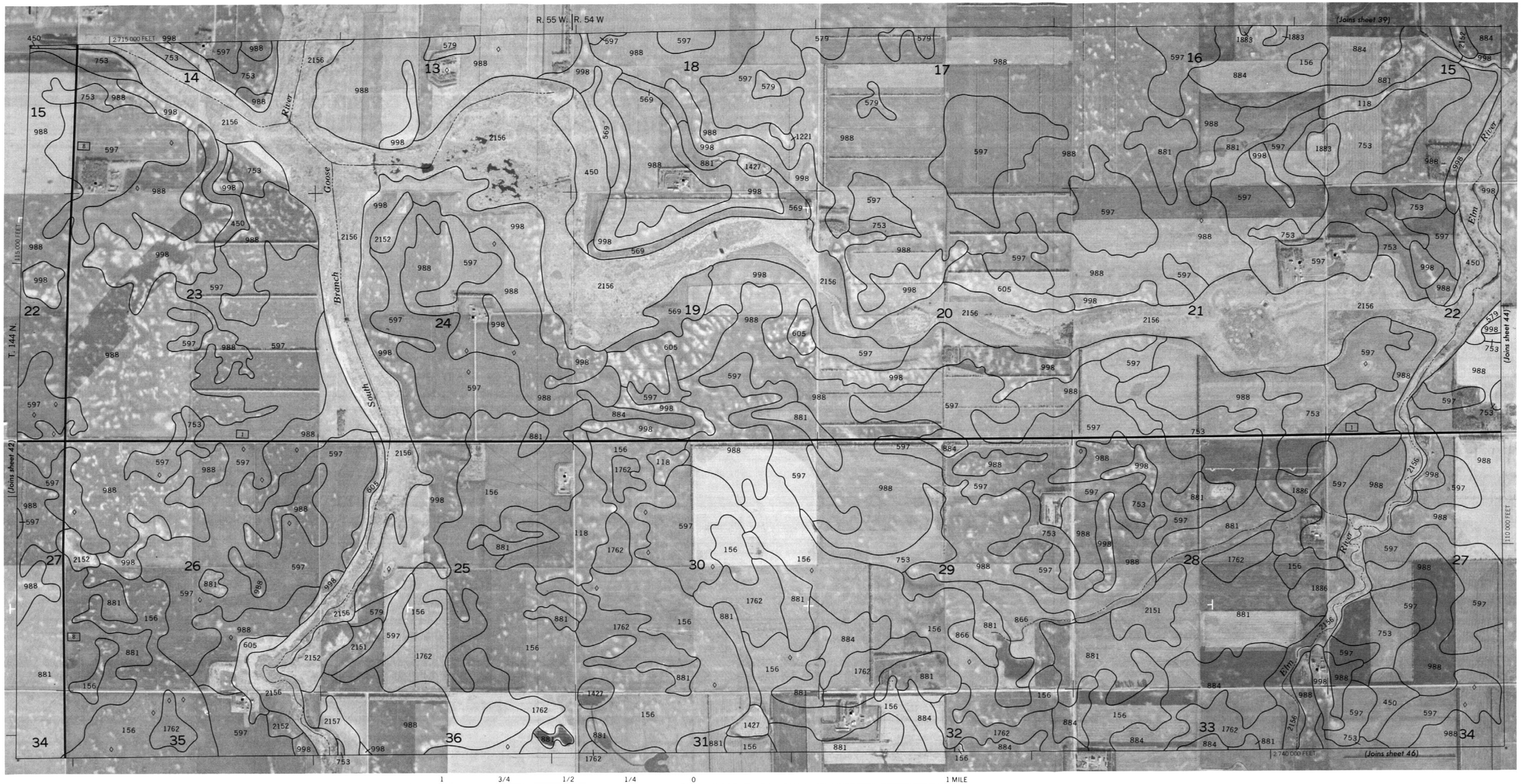
1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

STEELE COUNTY, NORTH DAKOTA NO. 42

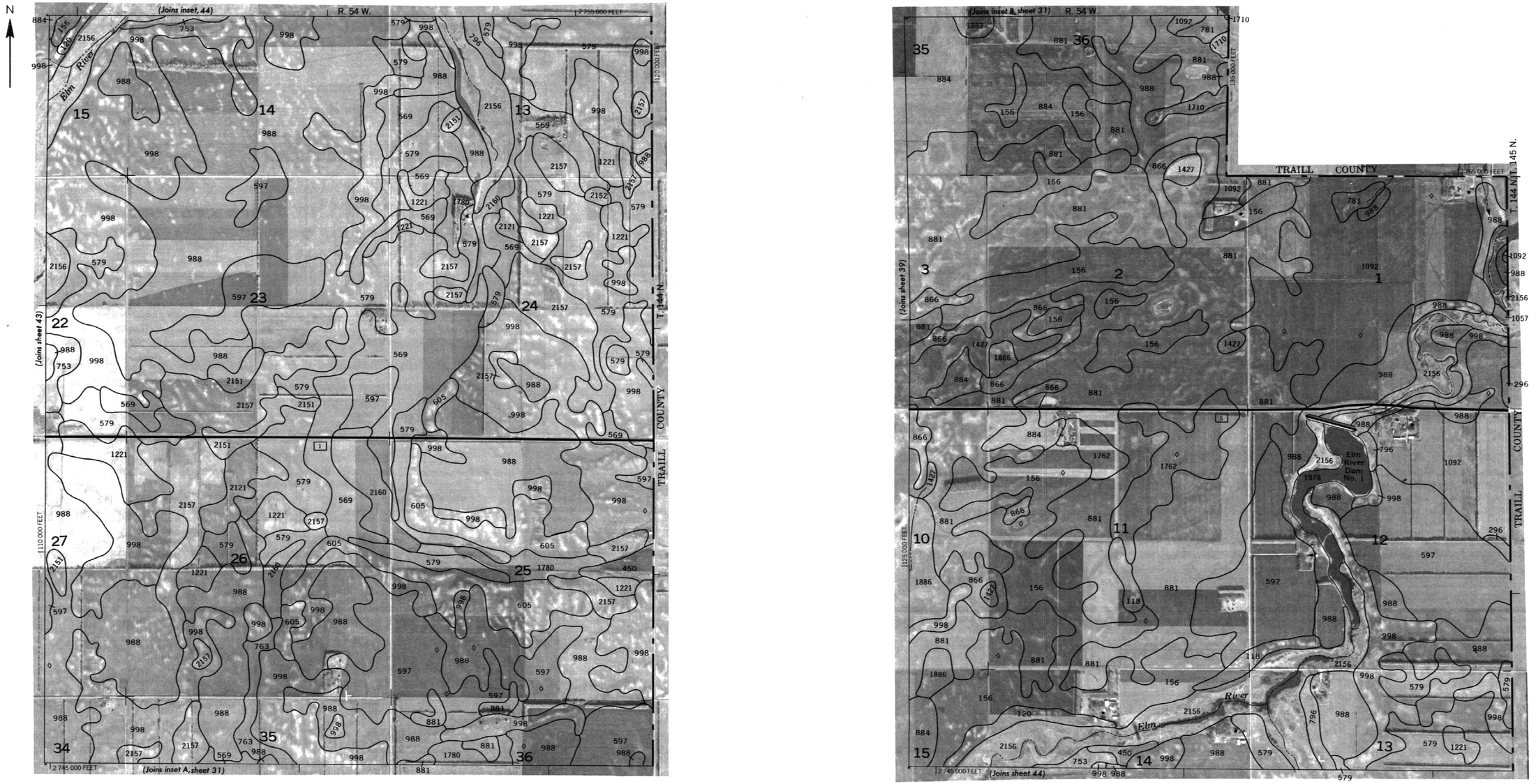
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



N

STEELE COUNTY, NORTH DAKOTA NO. 43

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 3/4 1/2 1/4 0 1 MILE

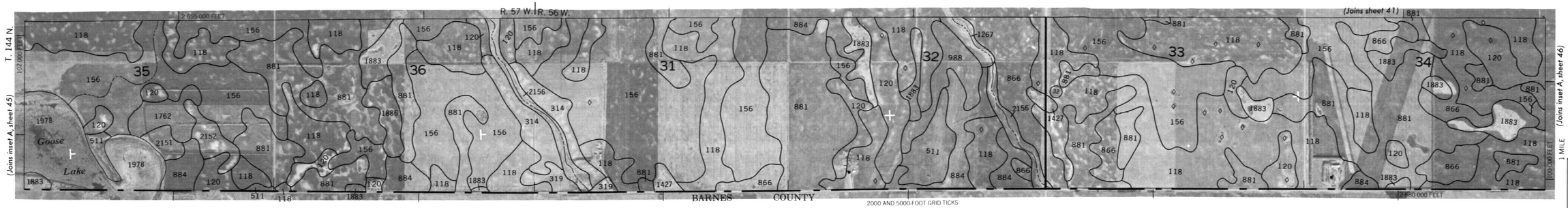
1 0.5 0 1 KILOMETER

SCALE 1:20 000

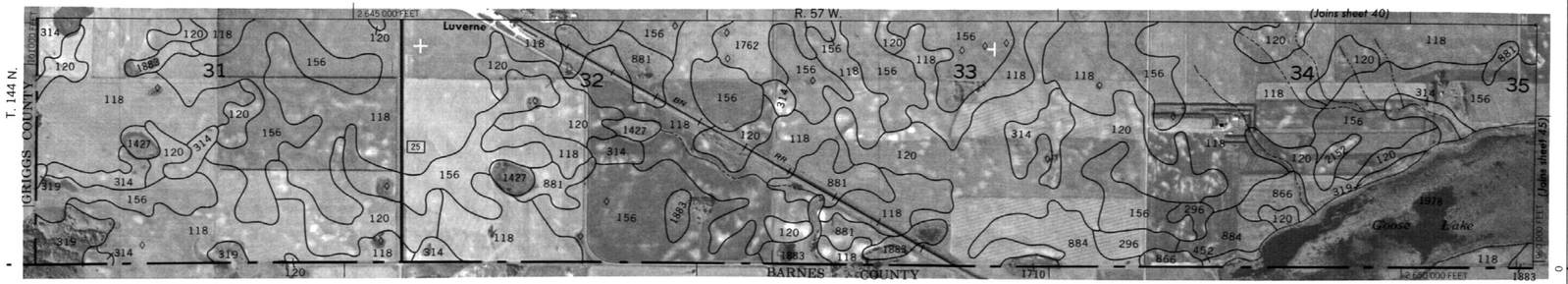
STEELE COUNTY, NORTH DAKOTA NO. 44

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

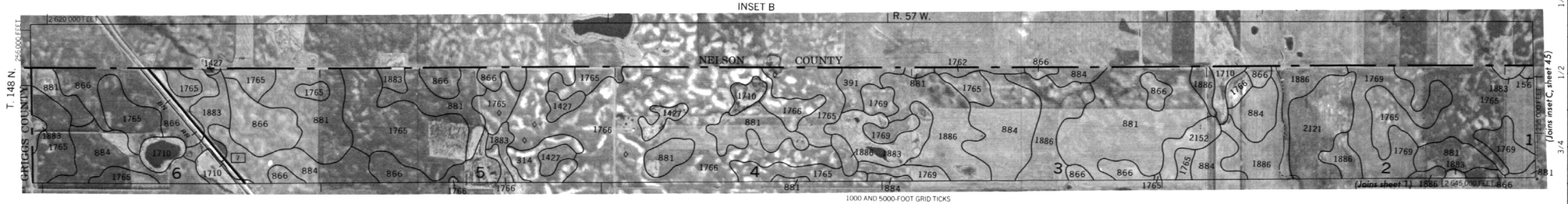
SOIL SURVEY OF STEELE COUNTY, NORTH DAKOTA — SHEET NUMBER 45



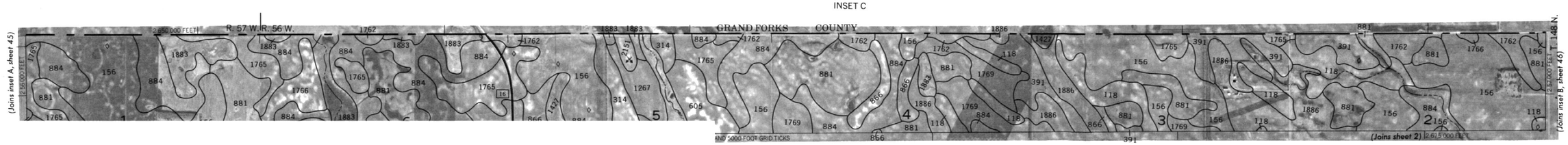
INSET A



INSET B



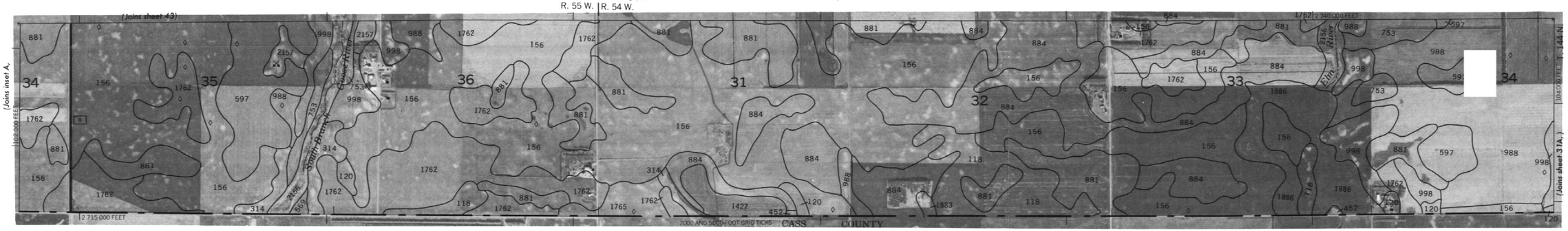
INSET C

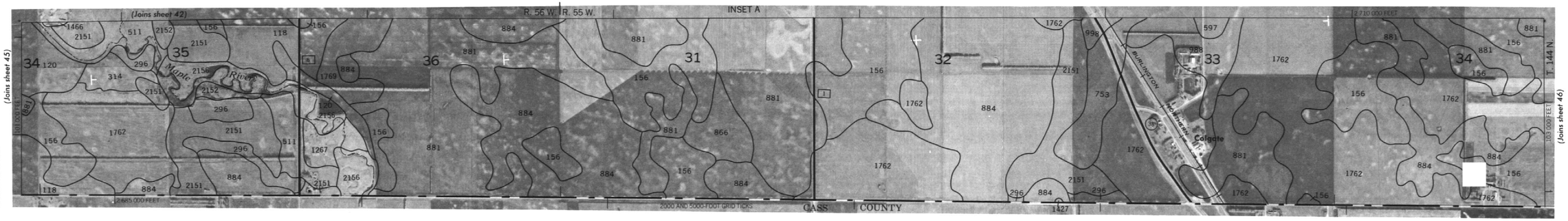


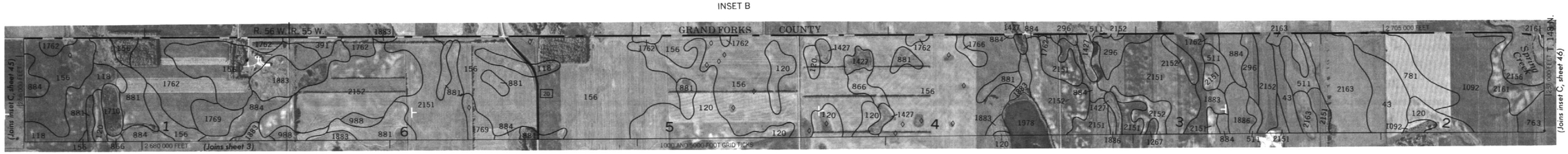
STEELE COUNTY, NORTH DAKOTA NO. 45

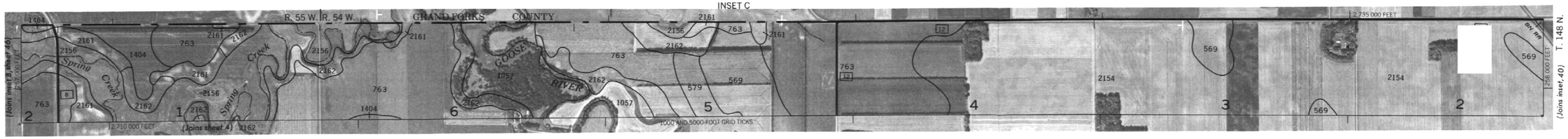
This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Base maps are from 1981-1982 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF STEELE COUNTY, NORTH DAKOTA — SHEET NUMBER 46









SCALE 1:20 000

1 MILE
1 KILOMETER

STEELE COUNTY, NORTH DAKOTA NO. 46

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies.
Base maps are from 1961-1962 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.